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the communiques of ant warfare. In other essays the author writes of modern advertisement techniques exploited by flowers and birds, of fish in Siam who have been selectively bred for fighting one another, of the resemblance between man and pig, of sex-determination before birth.

The author of this book, with his quiet sense of humour and immense fund of biological information, enhanced by personal knowledge and observation, brings something new into popular literature. Certainly these fascinating essays will have a wide appeal amongst laymen as well as providing a valuable and important addition to many scientific libraries.

NOTHING NEW UNDER THE SUN

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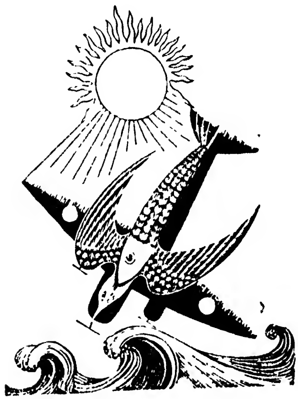
by

J. P. LOCKHART-MUMMERY

F.R.C.S., M.A.



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PREFACE

Nothing is new; we walk where others went.
—HERRICK

THIS old phrase contains more truth than most people imagine.

After all, this world is very very old, as we reckon age. How old we cannot yet say with any certainty, but the most probable scientific estimates put the time which life, as opposed to mere matter, first appeared on the earth's surface as between 1,500 and 2,000 million years ago.

This is by any reckoning a long time and has afforded opportunity for very many things to happen, not only once but very many times. The laws of chance are curious, but we know that given sufficient time almost anything can happen, however improbable or unlikely.

A deal with playing cards which results in each of four players being dealt the whole of one of the four suits only occurs very occasionally, in fact the chances of such an occurrence are many millions to one, but about once in every two years someone writes to the papers to say that it has happened, and as not everyone who sees it does write to the papers, and even when they do write the papers do not always publish the letter, we may safely conclude that it happens even more often.

A friend of mine, the late Sir Landon Ronald, once took a bank at *chemin de fer* in the Casino at La Touquet which ran seventy-two coups before it lost. He sold it on the sixth coup and went out of the Casino to get some air and a drink. When he came back three-quarters of an hour later the same bank was still running in an unbroken sequence and continued to do so for another half-hour. It had been sold and bought many times. Had he retained it he would have gone to bed a very rich man.

Chance can solve almost any problem given enough time, and there is probably nothing that cannot happen in the course of a few million years.

Nature has, by the workings of chance, operating over millions of years, been able to produce all the incredible and amazing

varieties of living structures which now inhabit or have in the past inhabited this globe, and it would seem that in all that time very few possibilities have been missed and very few of the practical and scientific discoveries of modern man have failed to be exploited by living organisms long before man himself even began to think about such things.

The electric eel manufactured an electric current capable of paralysing its prey long before Volta discovered the first principles of electricity. Flight through the air was exploited by the early reptiles one hundred and fifty million years ago. The principle of the parachute, the kite and the propeller were all made use of long before the appearance of Man. The ants discovered the use of poison gas long before Germany was ever heard of. The principle of the submarine is almost as old as life.

Man's two greatest discoveries were made before the dawn of history, namely the discovery of how to make and use fire and how to make a cutting edge by chipping a flint or some other hard stone.

We do not know who was the first man who discovered how to make use of fire, or how he made that great discovery. It was one of the greatest discoveries ever made and was to have untold results in future ages. It enabled him to obtain heat to warm himself and light to see by in the dark interior of his cavern; it made it possible for him to cook his food and so render it more palatable and digestible; it enabled him to protect himself from the wild bear and the sabre-toothed tiger and to harden the tip of his wooden spear; ultimately it was to lead to the steam engine and electric light.

Another great discovery, about whose origin we are equally ignorant, was how to chip a flint so as to obtain a cutting edge. This for the first time made it possible for early man to trim his hair and nails and to make an axe with which he could fell trees to build a house or to provide himself with firewood. The cutting flint axe and the flint spearhead must also have been a great improvement on the blunt stone axe and wooden spear as offensive weapons.

These discoveries took place millions of years ago and no records were left of the time or place. The evidence of charred wood and chipped flint instruments which has been discovered in ancient gravels and in the sediment in old caverns clearly points to the fact that very early man knew how to use fire and flints, not only in Europe but in many parts of the world.

Whether the knowledge was spread by wandering tribes, or the discovery was made more or less simultaneously in different places, we shall never be able to know for certain. Carefully worked stone and flint tools and weapons have been discovered in considerable numbers in such distant parts as South America, Alaska and China in geological deposits which establish beyond question their construction millions of years ago.

Man, a comparatively late-comer among the living creatures of the earth, has made use of his power of reasoning and deduction to exploit the possibilities that the earth has afforded him. He is an imitative animal and, by copying what he can observe around him, he has been able to improve upon what he observes and to harness Nature herself to his service.

By watching the fish he has discovered how to swim beneath the ocean; by observing birds he has discovered the laws of flight and succeeded in flying himself.

Most of what he has achieved has been by observing the working of the natural forces in the world around him and by reasoning and experiment deducing the laws by which these forces work. Once the laws are known and understood it is no great step to be able to control these forces for his own ends.

Watt was impressed by the force generated in a boiling kettle that lifted the lid, and from this small beginning discovered how to make use of the power generated by boiling water to do useful work.

The discovery of the manner in which heat could be made to pump water and turn wheels by converting water into steam has been one of the major achievements of Man, at any rate as regards the benefits it has brought to human beings.

At the present time, when the greater part of the civilised world is concentrating all its energies upon reconstruction, it is interesting for a time to turn to the simple facts of life itself, which are really of far more importance than the continual quarrels between peoples and nations that at the most are only a stage in the development of some international controlling force for nations which will be able to act like the police force of a modern city and at long last afford security and freedom from aggression for all the people of the world. Then, and not till then, will the exploitation of human knowledge and wisdom for the benefit of all human beings be really possible.

Whatever may be the outcome of the late War, it will be but a chapter in the social development of the human race and of little importance a thousand years hence.

This series of essays is not intended to be a scientific treatise, nor is it meant to fulfil any purpose, moral or otherwise, beyond affording interest and amusement to my readers, and perhaps encouraging them to dip more deeply into the history of the living creatures which inhabit or have inhabited this small planet in which we men and women happen to live. In fact to study life rather than living.

CHAPTER I

IT PAYS TO ADVERTISE

How often do we see this phrase in the newspapers. It has become a common catch phrase of the advertising agents of the present day. One would almost suppose that the act of advertising is something new, one of the discoveries of modern commercial enterprise, and that the idea of disposing of goods, increasing the sale of a book, or the popularity of a cinema star by means of large coloured posters which easily catch the eye of the passer-by, or glaring lights on the hoardings, are an invention which came in with mass production and what is sometimes called "American salesmanship."

There are as many methods of advertising, as there are many uses for it. The vast majority of advertisements are grossly untrue and one often wonders how anyone can possibly be taken in by them. Others, while true, are deliberately misleading. The publication of deliberately false statements was made use of by our own and other Governments during the war and, if dishonest, at least had the excuse of official recognition.

It is obvious that it does pay to advertise, for otherwise those who have something to sell would not pay the large sums they do for advertisements. But it is quite a mistake to suppose that there is anything new about it. The whole art of advertising had been thoroughly exploited for millions of years before we human beings ever thought of it as a commercial proposition. There are depths of depravity and examples of ingenuity in the form of advertisements which have been exploited by nature for ages that we moderns have not even thought of, much less used.

Nature has exploited all the different kinds of advertisement and I doubt if any textbook on advertising methods would be

found to contain more than a small proportion of the actual methods which nature has made use of in the past. The flowering plants are all examples. The shape and colour of a flower like the primrose are designed with the object of attracting some insect, such as a bee, so that the pollen, which sticks on to its body, may be taken to another flower of the same kind and fertilize it. Not only is the brilliant colour of the flower meant to attract a visiting insect but in the depths of the bloom there are little pockets of sweet honey which are given away with each packet of pollen, an obvious anticipation of the idea of giving away a packet of pins with each purchase at the drapers, or the picture cards which used to be given away with each packet of cigarettes. The honey in the flowers is just a bribe and, apart from its value in this respect, is of no use to the plant.

The whole reproductive scheme of the flowering plants is dependent upon their powers of advertisement, for they have to rely upon insects to carry their reproductive cells from one individual plant to another. Without the aid of the insects they would have to depend on self-fertilization, which in no short space of time would result in their destruction. The whole scheme of colour and bribes is to attract the insects.

The perfume of flowers is another kind of advertisement with the same object, namely, the attraction of certain insects. Insects associate certain colours, shapes or perfumes with certain varieties of honey and thus act as the means of distributing correctly the pollen of one flower to another of the same kind. Indiscriminate advertising would be useless to the plant as it would be to the tradesman. True we have to-day some advertisements which advise the reader to "drink more milk" or "eat more mustard," and possibly it might pay for plants to advertise "eat more honey," but as most insects eat all they can anyway, it would be in all probability a waste of effort.

If all the plants displayed the same kind of advertisement, or offered the same kind of bribe, the correct pollen would only very occasionally reach the correct recipient, and so the plants have had to find some way by which their goods will only appeal to a certain kind of insect or bird. Careful discrimination in the method of advertising has been necessary.

This has been achieved in many different and curious ways. Sometimes the flower is so constructed that only one kind of insect can reach the honey owing to the shape or size of the flower.

Other plants have got over the difficulty by flowering at a

season when there are only a very few other flowers in bloom; of such are the primroses and violets, which blossom so early in the spring.

There are a very large number of ways in which flowers and plants attract to themselves the insects which will be of most use to them by carrying their pollen to another flower of the same species as themselves.

The intense competition for advertising purposes between the different plants and flowers has produced innumerable different shapes and colours and many different varieties of bribes and free presents in the form of honey and perfume, all of which have their special advantage in attracting insects or birds.

The furnishing firms who give away a wireless set or a complete set of cutlery to anyone who buys their furniture, or the weekly magazine that presents its readers with a free copy of the classics or a dictionary, are only making use of a very old device and are really not so generous as an apple tree that presents the birds with an entire apple in order to dispose of a few pips.

Advertising with plants is not a question of increasing profits; it is their very life, and without it they would cease to exist altogether.

Another example of what may be called advertising bribery is that exhibited by most fruit trees. Their fruit is just a well-advertised bribe to attract birds. The bird flies away with the fruit and spits out the stone, which is the germ of a new plant and too hard to be of any use to him. The chances are that it will fall on fresh ground and develop into another tree. The

fruit of an apple or a plum is merely the bribe offered to the birds to induce them to distribute the pips or stones on new ground, and the colour of the ripe fruit is an advertisement to the birds that the fruit is ripe and ready to be eaten. Who has not seen cherry stones dropped all over the place by starlings that have

raided a cherry orchard? The red or purple cherries have attracted the birds and they have accepted the bribe of the sweet fruit and done their part by dropping the stones over all the land around. Many kinds of small fruit, such as blackberries and gooseberries, are eaten entirely by birds, and the seeds, which are indigestible, pass through their intestines and are thus not only distributed widely but are also suitably manured so as to give them a good start. The fruit is nothing else than a bribe to ensure that the seeds will be properly distributed. This almost corresponds to the giving away of an entire set of Dickens to encourage people to buy a certain newspaper.

An ingenious and depraved form of advertisement is used by certain South African orchids. They imitate the smell of the female Ichneumon fly and thus attract the attention of the male fly, who believes from the smell that he has found a female of his own species who is asking for his attention. By this depraved device the orchid makes certain that the pollen is taken from one flower to another of the same kind.

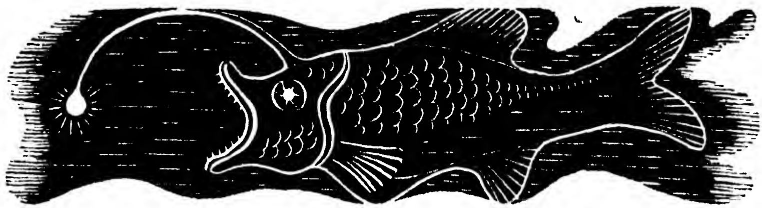
There are numerous examples in nature of skilled advertisement and much of the beauty of the world owes its origin to this fact. The orange attracts the monkeys and they quite unknowingly distribute the seeds.

The Venus flytrap, which is a well-known Brazilian orchid, might be compared to a money lender's advertisement. A collection of sweet honey is exhibited to the unsuspecting fly with a comfortable porch to alight on and a beautiful corridor to walk through. The entrance is easy and attractive, but owing to a number of skilfully placed hairs there is no coming back and it is not long before the unfortunate victim has been entirely digested.

Nature has not overlooked the advertising value of coloured

lights. The fireflies of the tropics attract their mates by the brilliant flashes of light they emit, sometimes merely a brilliant white light and sometimes red or green.

There is a fish who inhabits the ocean depths, where the daylight never penetrates, who carries a luminous lantern on a long stem in front of his mouth. Small fish and other inhabitants of the



sea-bed, no doubt inspired by curiosity, come to investigate the light and find themselves immediately sucked down into the fish's stomach.

There are numerous examples of insects which disguise themselves as something else and thus attract their prey. There is a spider in Brazil which looks like the droppings of a bird on a leaf, but the unfortunate insect which goes to investigate, in the hope of a good meal, soon finds itself being digested by what proves to be a spider in disguise.

The song of many birds and their wonderful coloured plumage are examples of display to attract others of their kind. Most of the beauty of the world in colour and song is due to the necessity of advertisement, and the bower birds that compete with each other to build gardens and houses out of coloured flowers to attract a mate would seem to have discovered that it pays to advertise.

Monkeys with brilliantly coloured behinds, several of whom can be seen in the monkey house at the London Zoo, are advertising their personal attractions just as effectually, and a good deal more cheaply, than the cinema star who has her name put up in Neon lights outside the cinema.

The song of the lark, the drumming of the woodpecker and the call of the cuckoo are examples of broadcasting advertisement.

If nature had not discovered the advantages of advertisement many millions of years ago, and had not exploited it to the full, this world we now live in would be a dull and uninteresting one indeed. Man is a very late comer in the advertising world, and he may well study nature's well tried methods and apply some of them for himself.

CHAPTER II

"S. A."

We hear a lot in these days about sex attraction. It is said of some woman, who is often not particularly beautiful or particularly clever, but who is very successful in attracting men's attention and is generally popular in men's society, that she has some strange gift called S. A. or sex attraction. We all know of instances of girls who, while quite good-looking and often having much above the average in brains and intelligence, never seem to get married and are always being passed over by the men of their acquaintance for women of apparently far less worth.

Sometimes this is because such women are too fastidious, but usually it is because they do not possess this curious gift of sex attraction. But few of the people who use the phrase have any clear idea in their mind as to what it really means. We all know that a beautiful woman, or one with a very good figure, attracts men much more easily than an ugly one or one with an ungainly figure and thick ankles. The well dressed woman, especially if she knows how to wear her clothes and move gracefully, is more attractive than the reverse.

A pleasant laugh, an engaging smile or a beautiful voice are all factors of great importance, but it is impossible to say that any one factor is of more importance than another. There are certain fortunate women who seem to combine all such gifts in one individual, and when this happens their power for good or evil is great. Of such were Semiramis, Cleopatra, Helen of Troy and many other famous women.

It is obvious that the living world could not continue unless sexual relationship took place, and in order that it may do so it is necessary that both sexes should desire it. The desire must be present or both parties would consider it as merely unpleasant or even disgusting, in which case it would soon cease to be practised and all living things would quickly come to an end.

Sex attraction of some kind or another which leads to sexual relationship is universal throughout the world of living things, although it takes many different forms. We know next to nothing about the sex attraction amongst the lower forms of life, although we can see it working when one minute piece of hydrozoan slime

amalgamates itself with another in order to form a fresh brood of similar slimes. We do not know what is the attraction that makes a male bee want to marry a female bee on the wedding flight which will result in his own immediate slaughter after the consummation of his marriage; or why the male spider should seek the embraces of the much larger female spider, who will in all probability eat him for dinner as soon as she has recovered from the thrills of the encounter.

The sex attraction among fish is even more difficult to understand as we know comparatively little about their sense organs. It would seem probable that it is something of the same nature as the smell in most land animals, but we do not know if fish can smell.

Anyone who is interested can see fish mating at the breeding season in the shallow bed of some stream with a sandy or gravelly bottom. I well remember watching a female gudgeon coming slowly up a river to deposit her eggs. On each side of her and a little way behind her were two male fish. Every now and then when she found a suitable patch of gravel she would stop and deposit some eggs, while both male fish mounted guard to keep away intruders, then one or both of the male fish would deposit their sperm on the eggs and with their pectoral fins shovel some gravel over the eggs to protect them. This process was continued at intervals up the river until all the eggs had been disposed of. It is difficult to understand what possible satisfaction the male fish obtains from this procedure. Much the same process can be seen with salmon on the spawning beds at the head of a river. The urge to get rid of their eggs, or sperm, under the proper conditions which will so far as possible ensure the success of the fertilized eggs, must be very strong in the case of salmon, judging by the enormous trouble and risk they run in coming right across the Atlantic Ocean and working their way laboriously up rapid rivers where there is little or no food and from which their chances of a safe return to the sea are not more than two to one. Most of the salmon, both male and female, that come into a river to spawn, die before they reach the sea again.

Many male fish will fight each other to death if there is a female of the species in the neighbourhood, although they will live together quite peacefully if no female is present. This may be observed in a tank containing trout. It is, therefore, quite evident that the male fish have some attraction towards the possession of the female which makes them want to get rid of any rival male, but it is very difficult to see why.

When we come to the higher forms of life we find that smell is the sense attraction. Certain glands, situated at the hind quarters of the female, become active during the breeding season and secrete an odour which causes violent sexual excitement in the males. This is readily observed in dogs. A bitch "on heat" will be followed by all the male dogs in the neighbourhood, and this form of sex attraction is common to nearly all vertebrate animals, from the humble mouse to the lordly elephant. There is no question of sexual love involved, as we know it. Love there may be, and certainly is, among dogs and horses and some of the higher animals, but it has little to do with sex. We often see examples of two animals being extremely fond of each other and inconsolable when parted, but they are generally of the same sex and not infrequently of different species, such as a sheep and a goat, or a dog and a horse. There is the love of a mother for her young, but of love between the sexes as a part of their sexual relationship there is no evidence among most animals, with the possible exception of some birds.

There is one great class of animal in which smell is not the sex attraction, namely birds. Smell as a sex attraction would be useless in birds for obvious reasons as no trail of scent can be kept in the air and the speed of birds is too great, and the medium in which they move too changeable, to render it of value. It is by the sense of vision, or hearing, that sex attraction works in birds. The brilliant plumage of the peacock, the bird of paradise and the pheasant are thus explained. The beautiful shapes and colours of birds are designed to excite and stimulate the sexual desire in the female birds, and in many birds the male's plumage only reaches its zenith at the breeding season. The male London sparrow is indisguishable from the female during most of the year, and it is only in the spring that he develops ruffles and puts on his plumage to make himself more attractive.

In many birds song is the sex attraction, and the song of the lark or the nightingale, the piping of the bullfinch, the noise of the cuckoo and the jay, have for their chief objects the attraction and excitement of a mate. It is S. A. in another form.

One of the most curious sex attractions is that exhibited by the bower birds of Brazil. The male bird builds an elaborate bower with pieces of coloured flowers, lacy grasses and small stones—a sort of summer house, in elaborate colours—and invites the female birds to choose the one they like best and mate with its owner and constructor. These bowers are often most elaborate and appear

to serve no useful purpose except as exhibits in a competition.

Among quite a number of birds an elaborate ceremony of movement is part of the sex excitement. The crested grebes perform an elaborate ceremony of bowing, presenting each other with pieces of leaf, or exhibitions of fancy diving and swimming. This is very similar to the dances of many of the native African tribes which are essentially sexual stimulants.

It is difficult to know whether there is anything among birds corresponding to the love of human beings, but at least, unlike most mammals, the male bird frequently takes his full share in protecting the eggs and in feeding and caring for the young and is faithful to his mate, at any rate during the breeding season. It has been positively asserted that the same couple of birds have been observed to mate in several successive years, which would seem to involve some form of love or affection similar to the affection and fidelity of humans. Birds certainly live a life of domesticity which in many ways resembles the family life of human beings and, like humans, sex attraction is through the sense of sight or hearing.

When our remote ancestors in the animal kingdom first began

to assume the erect posture, instead of going about on all fours, smell as a sex attraction began to become useless and appearance slowly took its place. The process of change must have been a very gradual one and even to-day human beings retain the remnants of the small glands which once had an important function. These vestigial glands now serve no useful purpose and are occasionally the cause of disease.

What the steps were in the change-over from smell to general appearances and manner, which is now the chief sex attraction in human beings, we can only conjecture, but we are afforded some clue by many monkeys whose highly coloured posteriors would seem to mark a transitional stage between the dog and ourselves.

It will thus be seen that S. A. has passed through many stages, taken many different and curious forms, and involved many different senses. In both birds and human beings the sex attraction is by means of the sense of sight and the reason why this has come about is similar, namely, that the sense of smell became useless for this purpose when birds took to the air and when human beings began to walk erect and their noses were no longer on the same level as their posteriors.

S. A. in intelligent human beings has become a very complex and subtle affair which is very difficult to define at all accurately, but that it is a very important factor in human life is unquestionable.

History shows that it has swayed kingdoms and empires, and has always been one of the greatest factors influencing the affairs of men. S. A. is responsible for great business and commercial enterprises. Where without it would be all the dressmakers' shops, the hat shops, modistes, beauty parlours, hairdressers, scent firms, etc., which to-day comprise one third of all the principal shopping centres of London, Paris and New York? If men ceased to be interested in the appearance of women, or to notice how they looked or dressed, which God forbid, it would cause financial disaster to a vast number of businesses and cause a revolution in trade throughout the civilized world. There is, however, nothing more unlikely to happen, and the amount of money spent daily, directly or indirectly, in adorning womankind is steadily increasing, and will increase. S. A. has come to stay and the modern siren has much greater possibilities of adornment than were ever possessed by Cleopatra or Semiramis.

CHAPTER III

THE CONQUEST OF THE AIR

If anyone were to ask when the conquest of the air first took place, the answer they would probably obtain would be that it happened at the beginning of this century, when Wilbur Wright, an American, flew for twenty minutes in a machine fitted with a petrol engine driving two screws. I can well remember the tremendous excitement everyone felt when they heard that at last someone had discovered how to fly and to keep in the air as long as twenty minutes.

As a matter of fact flying really began some one hundred and fifty million years ago, soon after living creatures left the water and took to life on the land.

Flight in the air had been thoroughly exploited millions of years before man first discovered how to imitate the birds and travel long distances through the air. Almost from the time when living organisms first succeeded in living on dry land some of them began to make use of the air by gliding or flying; in the first place probably to escape from their enemies, or maybe to reach some otherwise unobtainable food supply. One of the early reptiles, the Pterodactyl, which lived over one hundred million years ago and is now known only from fossil remains, was able to fly short distances. It had huge leathery wings, somewhat like those of a modern bat, and probably glided rather than flew from one high rock to another. It must have been an awe inspiring sight as it was more than four times the size of the largest bird living to-day.

Of the earliest birds and insects we know very little, but they must have achieved flight in the very early days of the land creatures. Possibly the fish were the first to take to the air, the ancestors of the flying fish of to-day.

Many plants have made use of flight in some form or another, generally with the object of carrying their seeds to a distance from the parent plant and so affording their progeny a special advantage.

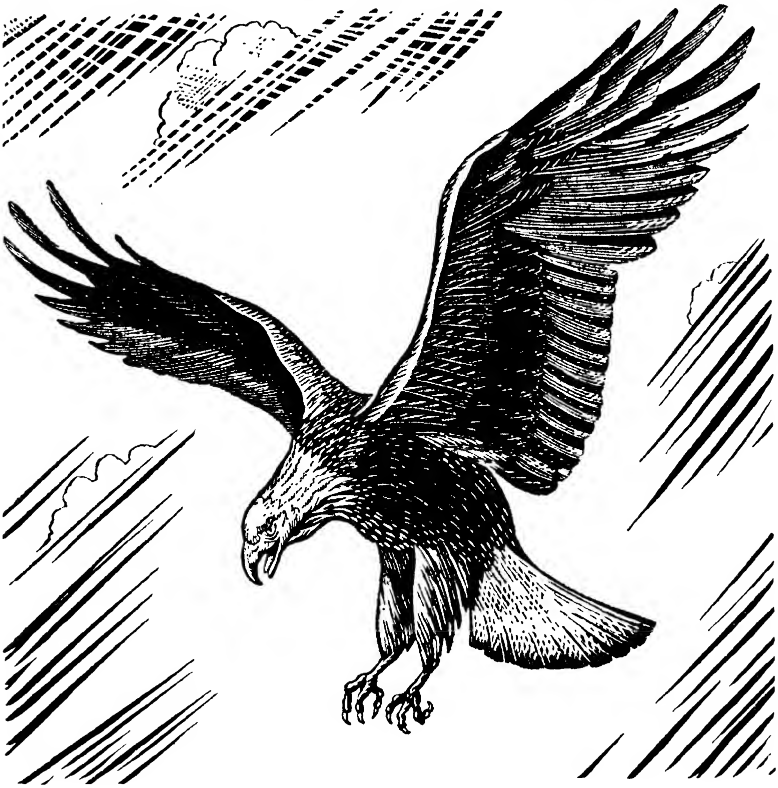
In many cases the parachute principle has been used to float the seed pods away from the parent plant and all sorts of strange, and often beautiful, designs have been employed. A large surface produced by a number of very fine hair-like threads attached by a short stalk to the seed pods is a common form, and in a light wind such a contrivance may be seen floating high in the air for quite a considerable distance before it at last comes to earth. The dandelion seeds are a good example of this form of parachute.

Others depend on the principle of the screw propeller. The plane trees make use of a single-bladed propeller, the heavy seed-pod being placed at what would, if there were two blades, be the axis; as it falls through the air the blade rapidly revolves and acts as a parachute to delay the fall. Other trees make use of a sloping plane with the weight well below and out of centre, so that the whole contrivance goes sideways as it falls.

There are innumerable different kinds of seed-pod cases which enable the seed to travel quite long distances through the air, under suitable conditions; naturally the best conditions are when there is a strong wind which will also tend to loosen the seed-pods from the tree and start them on their journey.

Many spiders make use of the wind to travel through the air. They climb up a tall spike of grass, or some high plant, and wait for a suitable wind; then they let out a long thread which trails away in the wind and when it reaches a sufficient length to get a good grip on the air the spider floats off through space attached to the other end of the thread. Once in flight the spider can control matters within certain limits though he cannot, of course, do much to alter his direction. By letting out more and more thread he can prolong his flight, and by drawing it in he can descend when he wishes to do so. This is the same principle as the kite.

Birds, of course, use gliding in air currents as an aid to actual flying and many of the larger birds, such as the albatross and the eagle, would be unable to stay long in the air if it were not for their dexterity in gliding. Everyone must have watched a seagull in the wake of a steamer easily keeping pace with the ships without any movement of its wings beyond that necessary to keep its



balance. The bird, of course, is making use of the up current from the stern of the ship to maintain it in the air and to carry it along. Seagulls can in this way keep up with a fast ship for hours with practically no effort beyond that necessary to balance themselves.

The Buzzards glide for miles in a gentle breeze and make use of every current of air in a similar manner to that of an expert member of one of our modern gliding clubs.

The vultures of Eastern climates, who spend the whole day in the sky, do very little actual flying; most of the time they glide round in endless circles, sustained by the air current produced by the heat rising from the earth.

Actual power flight, as distinct from gliding, has been utilised in a great many ways by both birds and insects. The most perfect examples are probably the martins and swallows, who not only fly at great speed, but can maintain it for many hours at a time over great distances, and the hawks who are unrivalled for speed and manœuvering power. Duck and geese, though they are comparatively heavy birds, are capable of travelling immense distances; some of them travel round the world once a year, wintering near the South Pole and spending the summer near the North Pole.

Some birds are capable of flying very long distances without alighting, thus 200 miles a day is not unusual, and the Golden Plover of the Pacific is credited with being able to fly 2,000 miles without stopping at all.

As a rule the small birds fly faster than the larger ones, but no very exact observations have been made. From 50 to 100 miles per hour are high speeds and from 20 to 40 miles per hour is about the average speed of small song birds, such as larks and thrushes.

There appears to be a very definite limit to the size which a flying bird can reach. All the very large birds, such as the albatross, the vulture and the kite depend on gliding rather than the movement of their wings for sustained flight, and all the largest and heaviest birds, such as the ostrich, the Emperor penguins and the now extinct Dodo must have lost their ability to fly before they reached their large size. In other words their weight was only obtained by sacrificing their ability to fly or, what is more probable, they never were able to fly but stopped in the infantile stage when wings are only used to assist them to run, as is seen in young chickens, who make use of their wings to run faster but are as yet unable to leave the ground.

We cannot at present be certain whether such birds as the ostrich and the penguin are descended from earlier flying birds or if they represent a primitive type of bird which has never been able to fly. The latter view seems the most probable.

Some birds, such as the cormorants, can fly quite well and yet when they dive into the sea use their wings for the purpose of swimming under water.

Insects have a different kind of flight from that of birds and, perhaps fortunately for man, have been unable to attain a large size owing to their breathing apparatus, which imposes a maximum width to their bodies of roughly half an inch and which cannot be greatly exceeded. Instead of breathing with lungs insects have fine branching channels passing all through their tissues and connected to small openings like portholes along their sides. The oxygen reaches their tissues direct from the air along these fine channels by a simple process of percolation, and although this method of supplying the tissues with oxygen is quite efficient over very short distances, such as a quarter of an inch, at longer distances than this it will not function at all and consequently a really large beetle, or other insect, cannot exist. The largest beetle known is barely an inch across, which from our point of view is probably fortunate as a really large flying beetle, the size of a horse, would be a tricky and dangerous antagonist.

Insects have developed the principle of the helicopter rather than the aeroplane, and the action of their wings more nearly resembles the screw propeller than the moving plane of birds. The movement of the wings in many insects is extremely rapid, some 200-300 beats per minute in the case of many flies, and they can rise directly into the air from a standing start, relying almost entirely on a direct lift produced by the wing movement.

Birds require a preliminary run or jump to start their flight and if their legs are badly damaged are unable to leave the ground, although the amount of run they require is often very little more than a quick jump.

Heavy birds like ducks or swans require a long run to get into the air unless assisted by a strong wind, and many aquatic birds, such as swans, cannot get into the air except off water.

A swan cannot get off the ground into the air as he is not able to run fast enough to acquire the necessary lift, and even in water he requires a run along the surface of the water of some fifty yards before he can get enough lift to leave the surface. His method of

getting into the air resembles that of a seaplane and he leaves a long trail of white foam behind before he leaves the water. Even when he is up he does not seem to be able to fly at any great height and generally keeps only some twenty to thirty feet above the land.

A seagull, on the other hand, seems to be able to jump into the air from the surface of the sea, but he does go into the wind to assist his lift.

There is another form of flight which has become highly developed in many insects, and in a few birds, the exact mechanics of which is not understood, and which we are quite unable to imitate at present. This is the ability to remain stationary in the air without gliding or the use of air currents. Bees are able to do this, but it is best seen in some of the bot flies. The insect can remain quite stationary in the air, with its wings moving at high speed, and then move away in any direction like a flash. The same curious method of flight is beautifully illustrated in humming birds. They will remain immovable in the air while they suck the honey from some flower with their long tongues, their wings moving so fast that it is impossible to see the movement. Then they will move away quicker than the eye can follow, and again remain stationary opposite another flower. They move so fast and so suddenly that they seem to be constantly disappearing and appearing again.

The human eye cannot see a movement which takes place faster than a twentieth of a second, and it is by the exploitation of this fact that the cinematograph has been made possible. If the pictures are changed at a rate of twenty per second, the human eye is quite unconscious of the change and only observes a continuous movement due to slight alteration in the successive pictures presented. The humming bird and some insects move from one place to another so fast that during the movement they become invisible. Some of the tricks of conjurors are produced by exploiting the same principle.

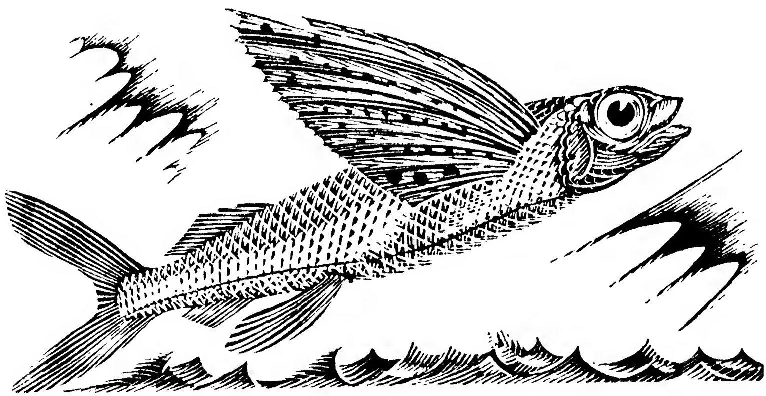
The lighter than air principle, which man has used in balloons, has not been utilized in the history of life and would appear to afford no advantages.

It is evident, even from these few facts, that we have yet a very great deal to learn about flying and that at present we are only beginners in a field which has been exploited over long ages and developed probably to its limits. In two respects it seems possible that man may eventually succeed in going one better than

the birds and insects. One of these is in sheer speed. Man-made flying machines have attained speeds of over 600 miles per hour, which is certainly faster than any bird or insect can fly. But this is because for mechanical reasons birds are unable to produce sufficient power in proportion to their size; nor are such speeds economical, and it is probable that the best speed for aeroplanes is not much higher than 120 miles per hour.

The other way in which man may in time prove superior to birds in flight is in being able to fly in the stratosphere. If this becomes possible very high speeds will be attainable, with very little expenditure of fuel. The pilot and passengers would, of course, have to carry their own air with them and would have to protect themselves against the lowering of pressure and temperature, but these difficulties can be overcome. It was thought at one time that the cold at these high altitudes would render life impossible, but the upper layers of the atmosphere are not so cold as was at one time thought. The greatest difficulty about flying in the stratosphere, however, arises from the difficulty of getting there without having to employ such high rates of acceleration that the human brain and nervous system will be damaged in the process.

The speed and weight-lifting capacity of man-made flying machines is much greater than that of any birds, but in safety in alighting and the ability to hover they are as yet far behind both birds and insects.



CHAPTER IV

NATURAL ENEMIES

IN one sense almost every living organism is the natural enemy of all the others, since with very few exceptions it either preys upon others for its food or is preyed upon for the same reason. Even the herbivorous animals, such as the cow and the sheep, live by consuming the living plants which form their diet.

The plants obtain nourishment from the air and from minerals and decaying matter in the soil, though there are even exceptions to this rule since some of the orchids and a few water plants entice insects to settle upon them by secreting a sweet juice and then entangle the insects in their tendrils or entrap them (as in the case of the orchid called "Venus's Flytrap") and digest their captives.

All the animals, however, live upon other living things, either vegetable or animal, and are quite incapable of obtaining their nourishment from inorganic materials.

Apart from this natural enmity, which exists between all living animals, there are very many curious examples of animals and living organisms which exhibit a special enmity to some other particular species. Dogs, for instance, are the natural enemy of the rat and the cat. Weasels, stoats and ferrets are the natural enemy of rabbits, and under conditions where man does not interfere these small rodents keep down the rabbit population and prevent rabbits from becoming excessively numerous. The rabbits are unable to put up a successful defence against them and since these small but ferocious animals are able to go down the rabbit holes and capture what rabbits they require in the burrows,

the only defence left to the rabbits is to breed so fast that there are always more rabbits than the stoats, weasels and ferrets can eat.

When man interferes in this natural warfare by destroying the stoats, weasels and ferrets, as is the case in places where there are game preserves, the rabbit population at once increases enormously. The gamekeepers shoot all the small rodents as vermin because they kill young pheasants and partridges, and by so doing remove the rabbit's natural enemies. As a result in very many places the rabbits have increased to such an extent that they literally swarm in preserved areas and the farmers complain that they do serious damage to the crops, with the result that men, with the assistance of tame ferrets, have to be specially employed to trap and net the rabbits. It is not uncommon to find that as many as fifteen to twenty thousand rabbits are trapped annually on a single shooting estate.

The destruction of small birds by so-called sportsmen at one time became so prevalent in England, after the invention of the cheap sporting gun, that a law had to be passed prohibiting the shooting of small birds because, as a result of their destruction, the insects on which they fed became a menace. Trees were destroyed by myriads of caterpillars, which ate all the green leaves, and swarms of flies became a nuisance and a source of disease.

In France, where no such laws exist for the protection of small birds, the latter have to a large extent disappeared, and larks, sparrows, swallows and blackbirds are quite uncommon as compared with England.

The plovers in Great Britain, or curlews as they are sometimes called, were threatened by extermination because their eggs were considered a great delicacy, and in the spring when the birds breed the eggs were collected in great quantities and sent to the nearest market, where they commanded a good price and a ready sale. A law was passed that prohibited the sale of plovers' eggs and imposed a heavy fine on anyone offering them for sale. This entirely killed the trade in plovers' eggs and as a result the plovers have increased in number so that now they are more numerous than ever and the law may have to be rescinded to prevent plovers from becoming a nuisance.

There have been many instances where, in order to get rid of some animal that had become a pest, its natural enemy has been imported or encouraged. The result has generally been quite successful in getting rid of the pest, but there have often been strange and unexpected repercussions. From very ancient

times snakes have been used to get rid of rats and mice. The ancient cities of the East must have been overrun with these pests, who not only caused damage to stored food, but carried infected lice and fleas which were responsible for the plague epidemics that in olden times were constantly destroying whole populations. The snake and the cat are the natural enemies of rats and mice, and it is not by chance that they were made sacred in the Egypt of the Pharaohs, or that a snake twisted round a stick became the symbol of the healing art.

At one time Jamaica, one of the West Indian Islands, was troubled by a poisonous snake, the "Fer de lance", that was very common all over the island and caused yearly a number of deaths among the inhabitants. Someone conceived the brilliant idea of importing some families of Mongoose, a small weasel-like mammal which kills snakes, from India. This was carried out, and the mongoose families were brought by sea from India and let loose on the island to feed on the snakes. The mongooses thrived in their new surroundings, and very soon completely destroyed all the snakes, but having no more snakes to live on they began to kill chickens and soon became a much worse nuisance than the "Fer de lance" had been. It became impossible to keep chickens except inside chicken houses, or within enclosures of small mesh wire netting, whereas hitherto the natives had been in the habit of allowing their chickens to wander about freely. An outcry against the mongoose resulted, but it proved much more difficult to get rid of the mongooses than it had been to get rid of the snakes.

In many instances man has made use of his knowledge of natural enemies among animals and insects for his own ends and by using his knowledge with care and under careful scientific control has succeeded in obtaining the results he desired without any of the unfortunate consequences that occurred from the introduction of the mongoose into Jamaica.

At one time the orange groves of California in Western America were threatened with complete destruction owing to a blight which affected the leaves of the trees and soon destroyed the plants, or prevented the fruit from maturing. The orange groves were very profitable and the export of oranges from California was, and still is, a very important industry.

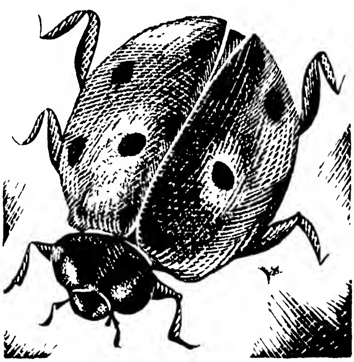
This particular blight had in a few years spread all along the coast and there was hardly a single orange grove which had escaped. Most elaborate schemes of spraying with insecticides were adopted and did a certain amount of good, but failed to

eradicate the pest, and spraying was so expensive that it seriously diminished the profits on the orange crop.

At this stage the American Board of Agriculture was asked to investigate matters and to try and suggest some means of combating the blight and so saving the orange industry of the Pacific Coast. The Board sent zoologists to California to look into the matter and they found that the blight which was attacking the orange trees was a small scale insect which fed on the leaves of the orange trees.

They next made inquiries in other parts of the world where there are also extensive orange groves and they found in Australia the same blight was also found to be attacking the orange trees, but that it had never become a serious nuisance. One of the American zoologists then went to Australia to investigate matters and he found that, while the same scale insect was found infecting the orange trees, it never increased sufficiently to cause serious trouble because there were large numbers of small beetles, "lady birds," which lived on the scale insects and kept their numbers down to an extent that prevented them from causing any serious damage to the trees.

A large number of these "lady bird" beetles were collected and brought all the way from Australia to California in suitable containers and placed in a special insect house. Then, when they had increased sufficiently in numbers, colonies of the beetles were released in the infected orange groves where they soon became established and started destroying the scale insects. The result was that the blight was stopped at very small cost to the orange growers, and there is no danger any more of the orange industry in California being seriously damaged from this cause.



Another even more interesting example of this method of dealing with a pest is now taking place in Australia. At one time the prickly pear cactus was becoming a serious nuisance in many parts of the Australian continent. It spread rapidly over great areas of sheep land and defied all efforts at eradication. Hacking it to pieces and burning were the only means of destroying it

but it grew faster than it was destroyed. So serious had the invasion of the prickly pear become that in some districts the ranchers were being driven off the land owing to its encroachment and the Australian Agricultural Board were called upon to try and save large areas of valuable land from becoming derelict.

The board found that there is a certain caterpillar of the moth, *cacto blastis cactorum*, which eats the prickly pear, so they imported some of these moths and started breeding them on a large scale. The moths' eggs were then placed on prickly pears and when the caterpillars appeared they began to eat the cactus. The insects bred rapidly and spread to other areas, so that at the present time the prickly pear cactus is fast disappearing from Australia.

Just recently some of the same caterpillars have been imported from Australia into South Africa to get rid of the cactus in that country. It was recently announced that 460 colonies of moth have now been established and the prickly pear is slowly, but surely, being destroyed there also.

When man starts to interfere with nature he is not always so fortunate as in the cases just quoted of the orange groves and the prickly pear. The importation of rabbits into Australia, a country where there were no natural rabbits, was disastrous, and the rabbits bred and multiplied to such an extent that they have become a serious pest. They have become much larger than the original imported rabbits and it costs the Australian Government many thousands of pounds a year to destroy them; even then they cannot be kept down and large sums of money have to be spent on rabbit netting.

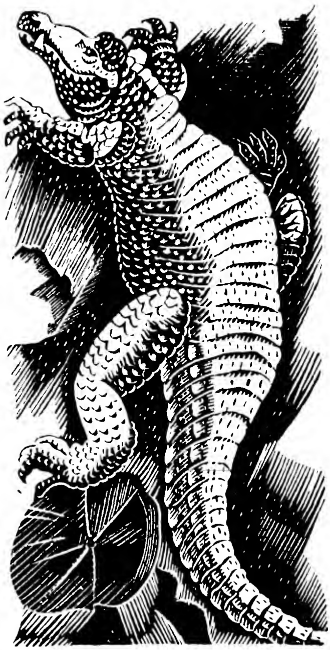
Professor Pasteur, many years ago, suggested that the Australian rabbits might be got rid of by infecting them with rabbit cholera, which does not infect man but is very fatal to rabbits. The Australians, however, refused to use this method as they were afraid of the possible consequence to their sheep and live stock.

Another example is the introduction of sparrows into New Zealand, where they have become a pest and cannot be eradicated. Man's interference often acts like putting a spanner into the works, and causes a lot of damage which he had not foreseen.

There is a certain large lake in North America where countless thousands of wild duck used to come annually to breed. At certain times of the year the lake swarmed with duck and large numbers were shot for food. Unfortunately some misguided person stocked the lake with turtles brought from somewhere else. For a time

all was well as a small furry mammal, indigenous to the district, ate the turtles eggs when they were deposited on the lake shore and so kept the turtles from becoming very numerous.

Unfortunately the furry mammals were found to be valuable on account of their fur and they were trapped and killed for the sake of their skins. Then the turtles rapidly increased in numbers and started to eat the young ducklings, with the result that the ducks completely deserted the lake for some other more suitable breeding ground, and most of the turtles died of starvation because there was nothing left for them to eat. The final result is that this lake is now no use to anyone, either for collecting skins, turtle eggs or ducks.



There are great tracts of country in Central Africa which cannot be exploited by the white races owing to the presence of a fly. This fly, called the tsetse fly, bites men and such animals as the horse and cow and infects them with a minute parasite which causes a disease known as Kala Aza, or sleeping sickness. This disease is slowly fatal in both men and animals, so that it is useless to import cattle and horses into those parts of Africa where the tsetse exists, as they cannot be kept alive. Without horses the land cannot be properly cultivated, nor is it safe for men to live in the area. Large sums of money have been expended to try and find some means of getting rid of the fly, or getting rid of the parasite. It is believed that the fly at one stage of its life cycle inhabits the crocodile, but any attempt to exterminate all the crocodiles in Central Africa is doomed to failure, and so far the parasite which is carried by the tsetse fly, and by him inoculated into man and animals, has resisted all attempts at elimination.

Some day a means may be found of destroying the parasite, or of effectively treating infected men and animals, and if that time comes vast tracts of country will be available for cattle grazing and cultivation. Quite possibly, however, the herds of cattle and other animals that are now kept within strict limits by the destructive efforts of the fly would so increase in numbers that the fertile plains would be overgrazed, and in time become sandy deserts, as has happened to great areas of once fertile land in Central North America. Perhaps, therefore, it is just as well that nature should keep large parts of Central Africa as a sanctuary against the invasion of man and his animals by means of the tsetse fly.

The same principle of making use of one form of animal or insect to destroy another has also been applied to the microscopic forms of life which we call bacteria and viruses.

A good many years ago Professor Metchnikoff, the Russian biologist, discovered that the coli bacillus which is normally found in the intestines of human beings and under certain circumstances causes disease and inflammation, cannot live in association with the lactic acid organism (*Bacillus Acidopholus*) that causes milk to go sour.

There is a kind of sour milk very popular in Bulgaria called "Koumiss" which is produced by adding the lactic acid bacillus to milk. The lactic acid bacillus is quite harmless to human beings and Metchnikoff found that if human beings took sour milk the *Bacillus Acidopholus* would breed in the colon and destroy and replace the coli bacillus, so that the latter could no longer be found in the intestine. This was one of the first instances of the substitution of one micro-organism by another and less harmful one, and since Metchnikoff's discovery this method has been extensively used in medical practice.

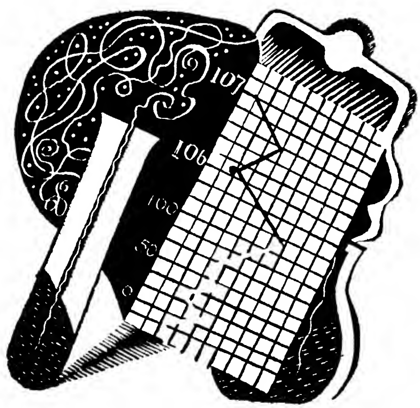
Smallpox is a disease caused by an infective virus, which is very readily transmitted from one human being to another by contact, or by clothes or other materials which have been near an infected person. The mortality from virulent smallpox is very high, as much as 60 to 70 per cent of those contracting the disease, and at one time it caused terrible epidemics which destroyed great numbers of people both in England and all over the world. Those persons who recovered from the disease had their faces pitted with scars, and a little more than a hundred years ago it was exceptional to see anyone whose face was not marked with such scars.

It is said that in 1790 a pickpocket who stole a purse in the Strand was caught very quickly owing to the fact that the owner of the purse noticed that he was not pock-marked. The polic looked for a man who was not pock-marked and soon apprehended the thief!

There is another similar disease called cowpox, because it attacks cows, and in 1798 Dr. Jenner observed that dairymaids who became infected with cowpox were immune from smallpox, and he tried deliberately infecting healthy people with cowpox in order to protect them against the more deadly smallpox. This was the beginnjng of vaccination, which is now compulsory in almost all civilised countries and has resulted in the almost complete elimination of what was once a deadly and almost universal disease.

There are many other examples of getting rid of one disease by giving the patient another one, but none so spectacular as vaccination.

Cases of general paralysis of the insane are sometimes successfully treated by deliberately infecting the patient with malaria by allowing a mosquito known to be infected with the parasite to bite him. Cases of rheumatism have also been treated by allowing bees to sting them with, it is said, satisfactory results; and some cases of desperate cancer have been cured by infecting the patient with erysipelas, an acute inflammatory disease, which causes a very high temperature, 106 or 107 F. No doubt there will be many more examples of this rather curious method of treating diseases in the future.



CHAPTER V

THE FIGHTING FISH OF SIAM

IMAGINE a small fish, not more than two and a-half to three inches in length, marvellously coloured pale blue with dark blue plumes or fins, iridescent green or ruby red, graceful as a duchess in a drawing-room. But many of you must have seen them in the Aquarium at the London Zoo. They are always kept in small tanks by themselves, as if put together they kill each other.

They rank among the most beautiful and graceful fish in existence, and certainly among the most ferocious. They always kill each other if given the opportunity and we can only suppose that in their natural haunts, the rivers and ponds of Siam, they remain separated by considerable distances. Their proper name is "Betta Splendens," and they belong to the family called Anabantids or bubble nest builders.

There are many instances of animals, and even fish, who fight each other at times, such as stags during the rutting season, cocks, buffalo, goats, and even trout, but these combats are unusual and only occur at the time of breeding to drive away other males from a desired female. These Siamese fish, however, always fight each other whenever they meet, quite irrespective of any season, though the males do not fight the females.

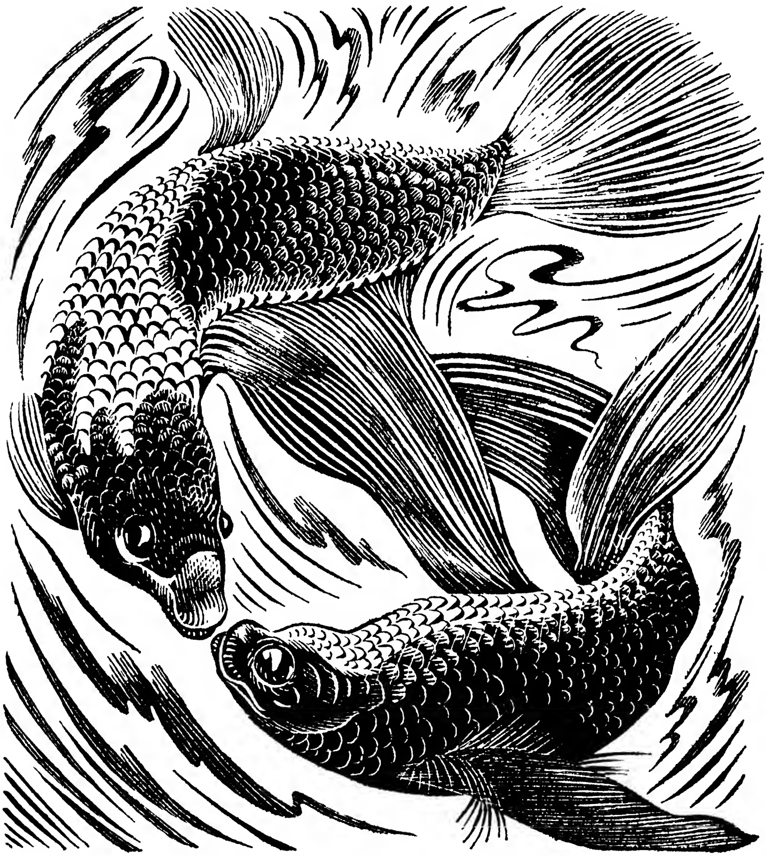
The Siamese long ago discovered this curious attribute of their fish and exploited it to their own benefit. Just as in the old days cock-fighting was (and even surreptitiously is to-day) a popular sport and large bets were made upon what was called "mains" between two cocks fighting to the death, so the Siamese encourage these fish to fight and bet on the result.

These fish have been specially bred for very many years by the Siamese to develop their natural fighting propensities. Thus, while the wild variety of these fish will rarely continue a fight for more than fifteen minutes the specially bred ones will fight with the utmost ferocity for sixty minutes on end, and some will continue to attack an opponent for as long as six hours.

An enormous number of these fish are artificially bred annually in the city of Bangkok, and there is quite a considerable trade in them. There are a number of specially licensed places where

combats take place in Siam. These fish seem to be absolutely fearless and good specimens will continue to fight as long as they have life left.

Two male fish are placed in a bowl of water hanging in the middle of a room, and the gamblers sit round and back the rival combatants. These fights are often to the death, and owing to the fact that, although of the same type, the individual fish are often of different colours, it is easy to distinguish them when with almost all other kinds of fish it would be impossible to tell one combatant from the other. It looks as if these fish had been evolved for the special purpose of gambling, as indeed to a large extent they have been.



Let me describe what happens when two of these fish are placed together in a tank or bowl. One of them is a beautiful iridescent green with rather darker green fins which spread out all round his body like a lady's train, and the other is similar in every respect but is ruby red all over. Both fish are about two and a half inches in length with bodies the shape of torpedoes and with trailing skirts of fin all round them. They swim slowly and gracefully about the glass bowl and for some time nothing happens except that they look at each other and then go away again. Next they begin to circle round each other, over and round in graceful circles, each sparring for an opening; then one suddenly turns and makes a dab at the other, tears off a piece of fin with his mouth and retreats with it. He swallows it, and then spits it out as if it were something repulsive, a most contemptuous and insulting gesture. This is repeated many times, first one and then the other tearing off a piece of fin from the other, until both are beginning to look much denuded of their natural adornments in the shape of fins; but this is only play and insult, it is not the real battle, which all depends upon a strangle-hold.

After much preliminary manœuvering and sparring for position, and much circling, darting and swooping, one suddenly seizes the other by the jaw. Apparently the correct hold is one on the lower jaw of the opponent. In this position they become locked together and sway about the bowl fixed together by their jaws; then they turn on their sides and sink to the bottom until one dies, or from pure exhaustion they let go of one another.

This peculiar hold is manœuvred for with much circling round and sparring, and then attained by a sudden quick dart. The best hold appears to be that in which the lower jaw of the opponent is gripped, as the fish whose upper jaw is held can breath more easily, but sheer endurance appears to be the chief deciding factor. The holds are maintained for quite a long time, often until both fish appear to be almost dead, then they separate and one slowly cruises round the glass bowl while the other and more exhausted opponent usually sinks to the bottom, where he may remain for some time. His less exhausted rival makes no attempt to attack him until he has entirely recovered and commences once more to swim about the bowl. They never seem to attack an opponent who is down and unable to retaliate.

Both fish then start once again to circle round each other and the fight recommences. The most uncanny feature of these fights is the fact that they take place in complete silence; only the

flashing colours as they roll about in the death grip indicates the deadly nature of the combat, until at last one fish sinks dying to the bottom and the winner cruises slowly and triumphantly round the field of battle.

If the fish are well matched in size and ferocity the ultimate issue may be in doubt until the very end and the battle may prove as exciting as that between two heavy-weight boxers. It may continue for a very long time. As a rule that fish is judged the winner whose opponent after a reasonable interval refuses to renew the combat.

In Bangkok, where these contests are staged, quite considerable sums are wagered upon the result of a fight. As a rule the fish are separated before either of them is killed.

Quite recently someone over-filled one of the tanks in which some of these fish are kept in the Aquarium in the London Zoo with the result that one of the fish was able to swim over the glass partition into the neighbouring tank where there was another fighting fish. In the morning both fish were found dead at the bottom of the tank.

The males do not fight the females, but if a pair are placed together in a breeding tank at spawning time it is advisable to remove the male after the spawning has been completed, or he may kill the female.

CHAPTER VI

HAS EVOLUTION BEEN HAPHAZARD?

WHEN we contemplate the results of evolution and the fact that *Homo Sapiens* has been evolved during vast ages from one simple sea animal we are apt to visualize the process as having occurred more or less in a series of straight lines.

A simple organism has slowly evolved into a more complicated one, a crawling organism into one that can walk, one that can walk into one that can fly and so on. We visualize evolution as having occurred in a series of steps, each step a little higher than the last, each form a little better adapted to cope with its environment than the last, each series of generations a little more perfect than the previous series, whether reckoned in thousands or in millions of years. In books on evolution we see charts and diagrams showing the simple unicellular organisms on one side, with radiating lines branching out from these to the more complicated organisms with blood vessels and brains, ultimately to man. These charts are very pleasing and seem to make evolution easy to understand, but it is certain that evolution has not proceeded in any such manner, although it is useful to make use of this method in tracing the ancestry of man.

We believe that evolution has occurred as the result of variations produced in the germ plasm as the result of mutations of genes and transmutations of chromosomes. These changes or mutations have been accidental, sometimes variations have been preserved by natural selection, and sometimes they have not.

The question of the preservation of a variation has depended upon its survival value, and this has depended very considerably upon the circumstances of the environment at the time the variation took place.

When the environment, that is the conditions of life, food, climate and so on, were favourable to the variation it tended to be preserved because it tended to increase the chances of survival for those individuals possessing it and to be handed on to future generations, so that soon there were many individuals with the variation and it had a chance of becoming permanent. It seems certain that variations have occurred in all directions, and the

vast majority of these variations have been either lethal, in that they have resulted in the death of all the variants, or else they have not been able to survive because the circumstances were not propitious. Only a very small percentage of variations have survived at any time to enable new types to be produced, and of those that have had survival value and have gone to the ultimate production of new types only a very few have been in the direction of what may be called higher types. The majority of variations have probably resulted in lower types. The same variations must have occurred hundreds of times, but it has only been when they were propitious, that is suited to the conditions of the environment, that they survived.

Variations may be of any kind and one that we should consider to be toward a better type is no more likely to occur than one towards what we should consider a lower type. Variations have always occurred of every kind and their chance of becoming perpetuated must have depended upon very many circumstances, but there seems no reason to suppose that improvement was any more likely, or even as likely, in the direction of a more perfect type than in that of a less perfect one.

Evolution since life first began has been going on in all directions, but man has been so interested, since he first began to understand the process, in his own ancestry and that of the large animals that he has devoted but little attention to those living organisms that appear to have gone backwards in the procession. There are, of course, many examples. The Cyclestomes and the Chordata, which at the present time resemble sponges or jelly-fish rather than anything else, have descended from vertebrate animals and still exhibit undoubted evidence of their descent.

The whales, seals and all the sea mammals are examples of animals who have returned to live in the sea after their ancestors had attained to life on the land, and the whale still possesses a rudimentary leg. Such birds as the ostrich and the penguin have lost the ability to fly, which should have been their heritage, or else they never developed it. There are many other examples, and it is probable that, when this branch of biology has received more study, it will be found that there have been more examples of regression than of progression.

All the parasites must have reached their present state of evolution long after their hosts, and are probably examples of regression. They must be descended from forms which originally had an independent existence; to think otherwise is absurd, and

those parasites which are peculiar to one single species of animal must have adapted themselves to become parasitic on that species long after the species itself came into existence. Thus the parasite which causes malaria in man only exists in man and in a certain kind of female mosquito. It follows, therefore, that this parasite has been evolved from some other living form and that it only adapted itself to live in man and the mosquito after man existed. It is, therefore, a more recent product of evolution than man.

Very many parasites have achieved great perfection, as parasites, and can reproduce themselves within their hosts without any necessity for a free living stage at any period.

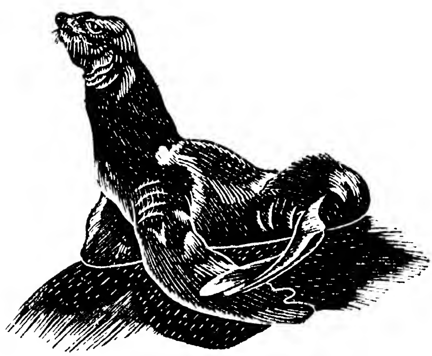
The best examples are the bacteria and viruses, which are responsible for so many of the diseases of man. The virus is the simplest form of parasite known. It is so small that it cannot be seen, with some possible exceptions, even with the latest form of microscope using ultra-violet light. It can pass through a porcelain filter and most of what is known about the viruses is the result of inference rather than direct observation. What they are descended from, we do not know. They may have been evolved from some plasmodium or amoeba, they may have been inconspicuous forms of life during the whole history of evolution, which adapted themselves almost at the beginning to live on another organism. They may be descendants of the first parasites of all, or they may at one time have been higher forms of organisms with definite structure, which have degenerated into parasites. We have no means of knowing, and it is all pure speculation. It all depends upon the point of view adopted. Man has attained the most complicated form of structure and the most complicated manner of behaviour, but the virus has attained the exact opposite. He lives entirely on his host; he has to do nothing except reproduce himself by division. He does not need to eat or work, and he can reproduce himself so fast that any individual virus can have a million descendants in a day, against man's one or two in twenty years.

It is, of course, pleasant to think that the whole process of evolution has had as its object the ultimate creation of that marvel of living organisms, man. But to reason in such a way is fallacious and quite unjustified by the facts. All creation has been haphazard, sometimes evolving something better and sometimes something worse. Fantastic objects, both in animals and plants, have been produced in the process, many of which it seems impossible could be of any real value. Such animals as the giraffe, the okapi

and the tortoise, such fish as the soap-fish and the sea-horse, are merely absurd, and there are many other examples of living animals, fish, birds and plants, which are mere absurdities as far as we can see.

Not only that, but in the process of evolution the same mistakes have turned up again and again. Animals too large to be successful, such as the ancient reptiles, the mastodon, the whale and the rhinoceros. Even in the case of man it is evident that if he is to progress, as surely he must, it will be necessary for him to have a larger brain, but this would appear to be an impossibility, as the human female's pelvis is not capable of bearing a baby whose head is any bigger than the babies of to-day, and indeed the human female suffers much more than any other female animal during the birth of her children because of the size of the human baby's head. Any further increase in the human brain is, therefore, impossible unless the human female can evolve a larger pelvis, which seems unlikely. It is a pity that man was not developed from a marsupial, such as the kangaroo, as then there would have been no limit fixed to the size to which his head might develop.

We can only conclude that evolution has been an entirely haphazard affair, subject only to the laws of chance.



CHAPTER VII

CURIOUS RESULTS OF EVOLUTION

THERE are many very odd creatures in this world, and as man with his inevitable curiosity always wants to understand how they have arisen, and why, it is not out of place to speculate on some of the more curious oddities of the animal kingdom, and to try and form some idea of how they have evolved.

Quite recently in the tropical sea-water section of the Aquarium at the London Zoo, which is I think the most wonderful aquarium in the world to-day, there were two soap-fish. These curious fish look like nothing so much as a cake of yellow soap about two inches long. The mouth is at the top corner at one end and the tail at the opposite bottom back corner. Needless to say they swim very badly as their shape is about the worst imaginable for reasonable progression in any direction. They are rectangular masses of tissue with quite inadequate fins, and of a pale yellow colour. They are simply grotesque, and there does not appear to be any possible or conceivable reason for their existence. One assumes that they must be the prey of any fish who fancies a mouthful of yellow soap, as they certainly could not escape. What they live on, or how they find their food, I do not know, but they are certainly the most extraordinary fish one could imagine in a nightmare.

Not far from them was another fish, the Dragon fish from the East Coast of Africa. This fish is equally grotesque; its shape is so odd that it cannot serve any useful purpose, and beyond a certain attempt at camouflage to resemble its surroundings one can see little value in its strange appearance, which seems to have been designed to frighten other fish.

The sea-horse, with which anyone who has visited the Aquarium must be familiar, is an even greater oddity; everything that can be is wrong with it. It can only swim very slowly in the most idiotic manner by flapping fins on the back of its head and where its behind ought to be. It looks like nothing so much as one of the knights from a set of chessmen.

It cannot conceivably serve any useful purpose except as food for some other form of fish, and its only protection seems to be

that it has a nasty hard exterior, and I should imagine very little inside. It probably survives because no one wants to eat it, and for no other reason.

These fish are fantastic, they belong to pantomime or comic opera, and it is impossible to take them seriously. They are evolution's sports—something thrown up in the general jumble; fantastic accidents which neither serve, nor can serve, any utilitarian purpose in the evolution of fishes. They go to prove how haphazard the whole process is.

Fish, perhaps more than other species of animal, present outrageous freaks. That part of the globe that consists of sea and fresh water is very large compared with the dry land and affords an almost unlimited area for the survival of different strange anomalies of evolution, for which there is not the same opportunity on dry land, and one would expect that water would furnish us with the strangest examples of organisms. There is a fish from Siam that is about two inches long and is quite transparent with the exception of its head. All its bones can be seen quite easily and there is nothing else, no stomach or intestine anywhere in its body; they are all situated in the head, and even its vent is situated just behind its gill plates. It appears to have been designed with the sole purpose of making the body entirely transparent and putting all the essential machinery into the head in order to make this possible. One of the results is that when stationary in the water it is always at an angle of forty-five degrees to the horizontal because its swimming bladder is also in its head and makes the head float higher than the rest of the body. But the sea is so full of quite extraordinary and grotesque forms that it is difficult to pick out any one kind as more odd than another.

The insect world has very many curious freaks which appear to have been manufactured in a playful mood. There is a spider in Brazil which looks exactly like the dropping of a bird on a leaf. The praying mantis, or stick insect, must be first seen to be believed, and it is hardly credible that such a form of life could in reality exist. One is left wondering by what concatenation of circumstances it could have been produced in the evolutionary process.

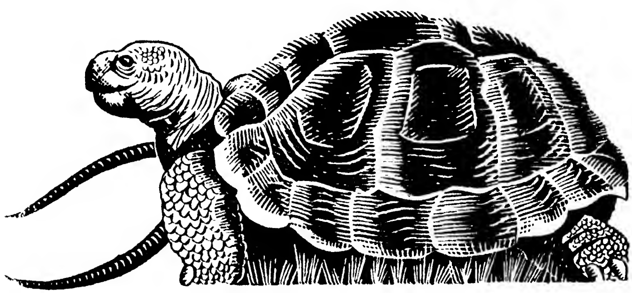
Some of the most curious beasts are the reptiles, of which there are only a comparatively few representatives now left, though at one time they appear to have ruled the animal kingdom for a period of some two hundred million years. Many reached a gigantic size, far larger than anything that now exists, with the possible exception of the sperm-whales. But they all died out and have left only a few representatives, none of which are very large.

The tortoises are the most interesting representatives of these ancient reptiles and one can only wonder how it is that they should have survived as one of the few remaining species of the vast family of gigantic reptiles that once owned the earth, sea and air. They seem to be particularly useless and generally ineffectual, but they can at least be proud of their ancient ancestry.

There is one curious species of tortoise which is a real puzzle

from an evolutionary point of view. Just below its head on the front edge of the lower part of the shell it has a projection of the lower shell much like a small but very stout pitch-fork. By means of this pitch-fork the tortoise can very easily turn another tortoise over on its back. It hitches the fork under the upper shell of the other tortoise and then by rising on its front legs turns the other tortoise over sideways. If not rescued the other tortoise must die of starvation as it is quite unable to turn itself back into the proper position. These particular tortoises cannot be kept with the other tortoises at the London Zoo as they turn them all over, but if placed with their own species they do not play this trick. The fork-like projection on the front lower shell appears to have been designed solely for the purpose of turning over other tortoises; it does not appear possible that it can have any other advantage.

It is interesting to try and speculate on the object for the development of this murderous weapon being evolved on a tortoise who would appear to gain no advantage by murdering other tortoises. One could easily understand it if the tortoise was carniverous and could eat the flesh of its victim, but all these tortoises are vegetable eaters and cannot eat flesh. It is possible that when this weapon was evolved there were very many tortoises and great competition existed for the existing supplies of green stuff. It might then have been an advantage to be able quickly and quietly to turn all the other tortoises on to their backs so as to be able to browse uninterruptedly upon the vegetation. This seems the only explanation as there are few examples of murder for its own sake among animals, with the exception of man.



CHAPTER VIII

HOW WAS MAN EVOLVED?

MAN, or to give him his proper scientific name *Homo Sapiens*, has evolved slowly from some simpler form, together with all the other living organisms that inhabit this earth. There cannot be many thinking people now living who still believe, as did most of our ancestors, that man was a special creation, quite apart from the rest of the animal kingdom; that man had been created by God in his own image and had always been much the same as he is now, at any rate in general appearance and configuration.

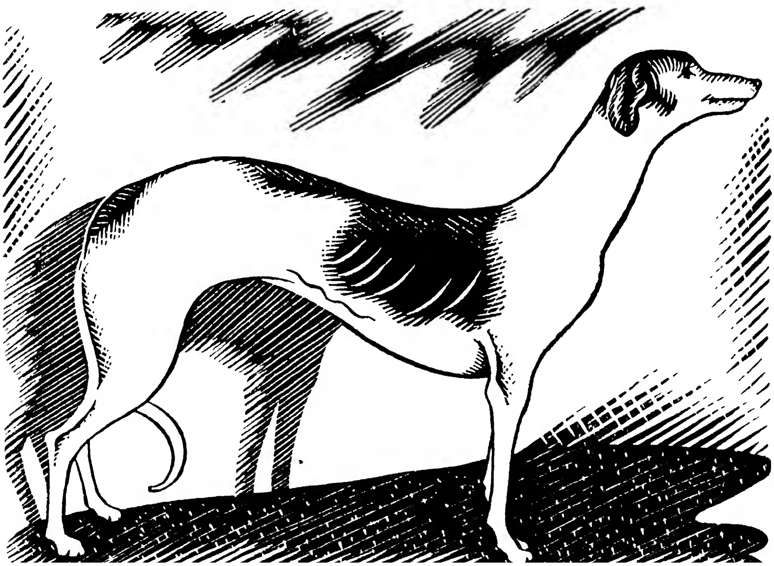
We are still very ignorant of many of the stages that have been passed through before man, as he now exists, was evolved, but there can be no manner of doubt that man is only one of the large phylum of mammals and shares, if we go back far enough into the past, a common ancestry with all other living organisms. Even to-day many people believe that man represents the most perfect form of living organism that has been evolved in the course of time; the final, or shall we say, the penultimate solution of evolution through the ages. It may be argued that since man unquestionably rules the earth and has made all the other forms of life his slaves, or at least put them under his control, and has harnessed many of the elements to his desires in a way that has never hitherto been achieved, he has a right to consider himself the most perfect type of animal, even if he must, in view of modern knowledge, resign the privilege of having been a special creation.

It is, however, more than doubtful if he is justified in any such belief. Man belongs to the phylum of the mammals, and although it is customary in text books to place man at the head of

this phylum as the most perfected form of mammal it is doubtful if he has any right there, except that man with his natural egotism likes to place his own species at the head of the list.

By a perfected form of organism we mean one which in the course of evolution has most completely adapted itself to its requirements in relation to the environment, so that it is difficult to see how any further improvement can take place. The horse is a good example. His evolution has been traced through millions of years by means of fossil remains and it seems at least improbable that any further radical improvement is possible. His teeth and digestive apparatus have been adapted to eating grass, his feet to running over the ground, his limbs to running at high speed, his skin to grow a thick coat to keep him warm and prevent the flying insects from attacking him, and his tail (though now generally docked for appearance sake) is well adapted to flicking off those flies that bother him. Anatomically the horse is a perfect specimen of a mammal that has become highly specialised in a single direction.

When we consider man from the same point of view we find that he can in no sense be considered automatically perfect; there are very many things wrong with him. He still has a vestigal extra stomach called the appendix which is not only quite useless to him, but is not infrequently a serious danger.



There are quite a number of vestigal structures in man which should not be present were he a high type of mammal. In many respects he is very imperfectly adapted; his skin has practically no protection either against cold, injury or insects, such hair as he has only partially protects his face. Were it not for the fact that he knows how to make and wear clothes he would be one of the most helpless of the mammalia. Anatomically he appears to be a comparatively recent experiment that as yet has reached no permanent solution. His bony skeleton conforms more closely to the primitive mammals than to the more highly specialised ones and his abdominal wall is still that best suited to an animal which walks on all four legs, and is quite unsuited to an erect position.

In four-legged animals the strongest part of the abdominal wall is above the navel and between it and the rib margin; here the fascia is specially strengthened to support the whole weight of the viscera which in a horizontal position must be supported on this and the abdominal muscles; it is the most dependent part of the abdominal cavity, while the abdominal wall towards the hips and pelvis is much weaker, since there is no tendency for the abdominal contents to exert pressure upwards and backwards in this direction.

In man, however, the abdominal wall still has the same arrangement as that present in the dog and the horse, which while perfectly adapted to a horizontal position is very ill adapted to an erect one. As a consequence man is seriously troubled by bulging of the lower part of the abdominal wall and by hernia which is caused by the viscera protruding through weak places in the muscles and fascia at the groins. It is equally evident that the great veins in the abdomen in man have not become adapted to the change from the horizontal to the erect position. They contain no valves to prevent the blood from flowing in the reverse direction and as a consequence too much pressure is exerted upon the valves in the veins in the legs and they are very liable to give way, with the production of the condition we call varicose veins. The absence of valves in the abdominal veins also results in undue pressure upon the delicate veins in the rectum, with the result that some fifty per cent of humans develop piles.

Man is obviously an experimental type of animal that is still very far from having adapted himself to the erect posture, and is very far from being a perfected species of mammal.

For several other reasons *Homo Sapiens* should be placed among the lower members of the mammalian phyla. His dentition

is a generalised one adapted to a varied rather than a specialised form of food, somewhere half-way between the carnivora and the herbivora. He can live on either animal or vegetable food and thrives best on a combination of both. He still retains the primitive form of having five digits on both fore and back limbs, which have become markedly modified in most other mammals, either into hooves or claws.

Another consideration that would seem to place man among the less perfect mammals is that his history, so far as it can at present be traced, is comparatively short, as compared with other members of his phylum. The horse, the lion and the hare can be traced in a recognisable form as far back as the earliest beginning of the mammals, but no mammal in the least resembling man can be discovered in the remote past when mammals first began to appear.

The origin of man still remains a very mysterious business. His earliest form appears to have arisen in comparatively recent times and to have branched out in several different directions, most of which have perished, leaving man the only example of his particular species in the world to-day. He resembles in many respects the more primitive type of animals that have remained immature, such as the shark and the ostrich, rather than the higher vertebrates, such as the flying birds, the horse and the lion.

If we agree that man on the evidence of his own anatomical structure cannot be placed among the higher mammals, how are we to explain his undoubted supremacy above all other living things? In two attributes man has a great advantage over all the other animals. The ability, which he shares with the higher apes, of being able to oppose his thumb and fingers and so grip things with his hands, and the development of a thinking and reasoning brain. Without these two attributes he would almost certainly have been exterminated millions of years ago, and the world would be a very different place from what it is to-day.

Various suggestions have been put forward to explain how man came to develop the thinking brain which has enabled him so successfully to exploit all his surroundings. It is possible that it was by a slow process of evolution similar to that which resulted in the development of the horse, but there are many objections against this theory.

Were it true there should be traces of man, or some creature resembling him, in a far more remote past than is actually the case. Also in the very early stages of his development, before he

had sufficient intelligence to make use of weapons to defend himself against other animals, he must have been exceptionally defenceless and liable to extermination. This would seem to argue that his development of a thinking brain must have occurred relatively fast and at a time when great changes in the environment were taking place.

During such periods, which have been frequent in the history of the earth, those animals that were not highly specialised and, therefore, most capable of adjustment to new conditions, would have a chance of relatively rapid evolution since by reason of their adaptability they could best adjust themselves to the changing conditions around and would survive to carry on the species.

As has already been pointed out there is evidence that man's change from the horizontal position to the erect one must have occurred fairly recently, since his anatomy has still not been properly adjusted to the altered position of his body in relation to the force of gravity.

There seems to be good reason for believing that man's great period of development into a thinking and reasoning creature must have occurred during a time when violent changes in the environment were taking place. The glacial periods were such times and it has been suggested that man was developed from ape-like ancestors that were living in forests at the beginning of the ice age, and that owing to the extension of the ice southward these forests were dying out and forcing man's ancestors to leave the trees which had been their home and take to life in caves and shelters among the rocks.

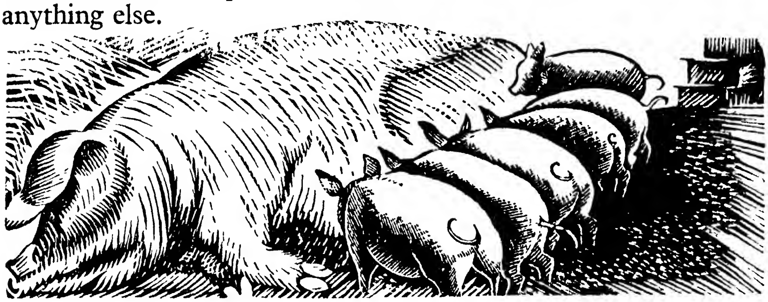
Such a situation may well have occurred on the high plains on the north of the Himalayas. The ice cap was creeping southward and destroying the forests, and the mountains to the south precluded any chance of further retreat towards warmer lands. Our ape ancestors may well have been among those who were thus trapped and could only survive through the thousands of years during which the ice age lasted by drastic adjustment to strange conditions of life in rocks and caves in place of forests. The Pleistocene ice age lasted, with some intermissions, for about 600,000 years and may well have been the time during which the startling evolution of *homo* from an arborial ape into an erect thinking man living in caves took place. The time is probably too short, but the earlier glacial period of Pleistocene times had a pre-glacial period of many thousands of years, so that the time may have been very much longer. At any rate the earliest traces

of man at present known (Piltdown skull) appear soon after this glacial period began to ebb about 300,000 years ago.

We shall probably never be able to discover how the change took place or what the stages in it were, as man until relatively recent times must have been a comparatively rare animal, only existing here and there in small numbers, and consequently has probably left few fossil remains to help us.

Balk has pointed out that man appears to have developed as a "foetalised" ape, meaning that the foetal stage of the ape became thrown forward, as it were, so that the foetal characters, such as hairlessness, were prolonged into adult life, and this elongated period of development would give time for the brain to enlarge. In other words, man is an ape that has never grown up.

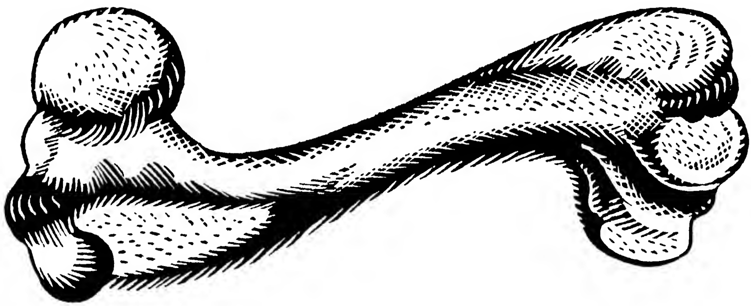
Another suggestion, which is particularly interesting, is that man has not developed from the lemur, but from the suidae, or pigs. This may not seem very flattering, but there are quite a number of very good reasons for this suggestion. The teeth of man more closely resemble those of the pig than of any other mammal. The bicuspids, or premolar teeth, of man have one or two roots, while the same teeth in the monkeys and apes have three, but the pig has the same number of roots to the premolar teeth as man. Also the arrangement of the intestines in man more closely resembles that of the pig than of any other mammal, and the uvula, a small projection at the back of the soft palate in man, which appears to be of no importance, is only found in a very rudimentary form or not at all in apes, but is well developed in pigs. There are numerous other anatomical similarities between man and pigs, such as the scarcity of hair and the very small tail, which at least make this suggestion as to man's nearest relative among the mammals of considerable interest. The pig also shares with man the ability to eat almost anything that is placed before him, while the apes are fruitarians and unable to live on anything else.



CHAPTER IX

WHY DO DOGS LIKE BONES?

THAT dogs do like bones I do not think anyone will dispute, or that dogs like bones better than any other form of diet. You may give your dog the best beef or liver and he will enjoy it, but give him a bone, a really nice bone with only a very little meat on it and perhaps a little marrow inside it, and he will desert your carefully prepared beef or liver for the bone, and will fight any dog that comes near him or even shows a passing interest in the bone.



Nor is this devotion to a bone peculiar to any particular kind of dog. Where bones are concerned all dogs are the same; the pampered pekinese, who has to be cajolled by his mistress before he will eat minced beef, will become a raging tornado of jealousy if given a bone, even though owing to the shape of his mouth he is not able to obtain much nourishment from his prize. The lordly greyhound will take a bone to his bed and woe betide even his own kennel boy should he attempt to remove it openly.

There is certainly something in the mind of a dog which makes a bone a very precious thing, to be guarded and hidden surreptitiously when possible.

Why should dogs like bones better than the meat itself? From the point of view of food meat is much better than bone; it has more nutritive value for its weight than bone, and is, or should be, more appetising. There is no particular merit in a bone; any merit

it has as nourishment depends upon the amount of meat that is still adhering to its outside; the bone itself is very poor value as food. In the first place it is very hard and requires a considerable amount of exertion to render it into a condition when it can be swallowed, and even if it can be all broken up and devoured the amount of actual nutriment is quite inadequate, when we consider the labour that is required. In fact, if one considers the actual facts, there does not seem to be any adequate reason why dogs should prefer a bone, with or without attached meat, to meat itself without the bone.

But anyone who has ever owned a dog (or should we say been owned by a dog), will know that the dog prefers a bone to any other form of nourishment. To him it is what caviare is to us. It is the height of luxury and he will take more trouble and be more jealous of a bone than he would be of the best piece of beef that you could give him.

The dog appears to have been associated with man from very early times and was almost certainly the first animal that became domesticated. Dogs' bones have been found mixed up with those of humans in the earliest neolithic burials. Most of the other bones found in such burials show evidence of having been broken or damaged, and presumably represent the remains of animals killed for food, but the bones of dogs have usually been found whole.

Even to-day a domesticated dog is of the utmost value to man in many ways; the dog's wonderful sense of smell, and his keen eyesight, are of great assistance to man in hunting wild animals, and as a guard at night to give a warning of danger he has no rival.

To neolithic man, who was still a wanderer and hunter, a trained dog must have been his most treasured possession. His dog helped him to track down game, warned him of danger at night, and protected his goods when he was away. The dog was as much part of his family as his wife and children.

But food in those days was scarce and difficult to come by. The man of the Stone Age must often have gone hungry for days and often weeks, before a fortunate kill provided abundant meat which enabled the whole tribe to stuff themselves to capacity. There was no means of preserving food and it had to be eaten at once. It was too precious to give to the dogs, and their share was the bones which the humans could not break with their teeth. From the earliest times the bones of the kill were thrown to the dogs, who waited outside the family circle for their share. The bones were their perquisite.

For hundreds of thousands of years domesticated dogs have been fed upon bones and in process of time those dogs which could make the best meal off bones have tended to survive better than those who could not.

The dog of to-day is no longer obliged to eat bones as food is plentiful and the scraps from his master's table provide him with all he requires, but the long apprenticeship to a diet of bones which his species has served during past ages, while he and his master, man, have been climbing slowly up the ladder from the cave-dwelling hunter dependent on a precarious diet to the pampered and overfed house-dweller of to-day, has left its mark in his canine mind, and a bone to him is still a bone, his greatest joy and his hard-won perquisite.

CHAPTER X

EVOLUTION AND DISEASE

At first sight it might be thought that there is not much connection between the evolution of living forms and the diseases of human beings, but if one considers the matter it is obvious that, as many of the diseases which attack human beings, and all epidemic diseases, are due to living organisms, these organisms must also have evolved in the course of time from previously existing forms—in fact, the organisms and parasites of disease are just as much the result of evolution as man himself.

We are perhaps too apt to think that evolution only works towards more elaborate forms of organism, and to forget that it works in all directions, some forms becoming simpler and others more complicated; some increasing their ability to harness and utilise their environment, some to diminish it; some becoming more active, others less active. There are numerous examples of evolution in both directions.

We are at present almost entirely ignorant of the steps which have occurred in the evolution of parasites. It is easy to suppose that the parasites have always been parasites, and that those we know have been evolved from simpler parasitic forms, but such thinking is certainly wrong. Parasites are descended from organisms which were originally capable of an independent existence and appear at some time to have evolved into a life of parasitism. Rafflesia, a flowering plant found in the Malay Peninsula, spends most of its life within another plant, consisting of a mere absorbing mass of fine filaments which penetrate the structure of the host. It has no specialised structure and absorbs all it requires from the juices of its host. Only when its reproduction becomes necessary does it exhibit any independent existence; it then comes to the surface of the host and forms huge flowers of elaborate structure. Can one doubt that such a parasite must originally have had an independent existence and that it has adapted itself to a parasitic existence comparatively late in evolutionary history? We find that at one stage of the life-cycle of very many parasites elaborate structure is still found and that in the embryo stages there is a free-living form.

If we are going to set up as our standard of the most perfect result of the evolution of organisms that organism which has

attained the most complete control over its environment, then *Homo Sapiens* must come out on top by a wide margin. But are we justified in assuming any such standard of perfection just because we happen to have attained it ourselves?

Evolution has not worked to attain any particular standard or to achieve any particular type of organism; it has worked haphazard in every direction. Might it not be equally true that the most perfect result of the evolution of organisms is the production of that organism with the simplest possible structure, with the ability to obtain food and other necessaries of life with the minimum of effort, with the simplest possible method of reproducing itself and with the ability to evolve, or if you prefer, to readjust itself to its environment with the greatest rapidity? If we assume *this* as our standard of perfection then we find that it has been achieved by the viruses and bacteria, and that they easily head the list.

We are naturally inclined to believe that man is the last, the most recent product of evolution; that he is the latest development of all the millions of years during which the process of evolution has been going on; that he represents the last brick, so to speak, placed upon the edifice, though not the final one. But such a belief is quite unsound and is logically and demonstrably incorrect. It is surely obvious that no parasite, no organism that lives upon another, can possibly have been evolved before its host has come into existence. The organism which acts as host must be evolved first before the parasite can have reached a stage in evolution which enables it to become parasitic upon that host. A parasite cannot exist before its host any more than a stockbroker can exist before there is a stock exchange, or a sailor before there is a ship. It must follow on purely logical grounds that man's parasites must have been evolved long after man himself.

It is sometimes assumed, and in a quite recent book by an eminent authority it is actually stated, that the earliest forms of life were the amoeba and the virus. But it is evident that the viruses of human disease are, as a matter of fact, a much later product of evolution than man himself; at any rate the amoeba of tropical dysentery must be so. It is inconceivable that the virus of smallpox can have been in existence before its host—man. A virus cannot have existed before its environment existed. It must be the other way about, and man must have existed for a very long period before the virus of smallpox and the amoeba of tropical dysentery had evolved to the stage when it could attack him. There

are numerous other examples. The spirechaete of syphilis could not have existed before man, for man is, as far as we know, its only host, and it seems probable that it only reached, comparatively recently, the stage when it could become parasitic in man. We have no evidence of the existence of syphilis among animals, though some monkeys can be infected with it, and there is no historical evidence of widespread syphilis before the time of Christopher Columbus. Syphilis is one of the diseases which leaves evidence of its existence in the bony structures of the human body, so that if a human being has had well-marked syphilis the bones will show evidence of the disease as long as they last. Although great numbers of the bones of the ancient Babylonian and Egyptian civilisations have been preserved for our observation no one has so far discovered any evidence of syphilis in the bones or skulls of the remains of these civilisations. It seems almost certain that syphilis did not exist in Europe, or the near East, until after the discovery of America by Columbus. It may be that, as has been supposed, Columbus and his men brought the disease over from South America, but we cannot be certain of this as there is no direct evidence, though it has been stated that some evidence of the disease is to be found among the relics of the Inca civilisations. In any case syphilis appears to be quite a modern disease and it is certainly of more recent origin than man himself.

The viruses of human disease must all be more recent than man. It is an unpleasant fact to face, but it is nevertheless logically certain that all the viruses which are the cause of so many of the epidemic diseases have been evolved long after man himself was evolved. Measles, scarlet fever, influenza, and numerous other diseases are peculiar to man and, therefore, the organisms causing them have evolved more recently than he has. The same is true of many other diseases due to bacteria, such as diphtheria, tetanus, gas gangrene, typhoid, cholera, plague, and human tuberculosis, and of a great number of parasites such as those of malaria, hookworm disease and sleeping sickness.

All the evidence seems to point to parasites having been evolved from organisms which originally had an independent existence and consequently a much more elaborate structure. It seems reasonable to argue that these, which at some stage in their life cycle have a free-living embryo and elaborate structure, must have taken to parasitism comparatively recently, while parasites which have evolved an entirely parasitic existence must be of more ancient origin and are the more perfected types.

The bacteria and viruses which cause disease in man have attained the most complete form of parasitic existence of all, since they have cast off all traces of elaborate structure or of independent existence, even for the purpose of reproduction. It seems only logical to consider that they too have been evolved from more elaborate and complicated organisms that in fact they are not the lowly forms of life we are accustomed to assume them to be, but the most perfect examples of parasitic evolution.

We know that evolution of species results from mutations or changes which occur in living organisms and which are preserved and encouraged by natural selection. That is, if a mutation occurs which has a possible chance of survival owing to the occurrence of a suitable environment, it will have a chance of surviving and forming a new variety or possibly a new species. The chances against any individual mutation surviving are very considerable, the vast majority of mutations for one reason or another die out, and it follows that the more rapidly any particular organism reproduces itself the greater will be the chance of mutations for new forms occurring and of any mutation surviving and being perpetuated in a given time. In other words, the more rapidly an organism reproduces itself the greater chance it has of evolving a new type of variant in a given time. The chances of any type of organism evolving a new variety, better suited to the environment or able to live in a different environment to the original organism, are obviously greater if the organism in question is one which reproduces itself very rapidly. Man, whose rate of reproduction is very slow, about three to four generations in a century, evolves very gradually. In the last 100,000 years there have no doubt been changes in man's structure but they have not been very great, and, if we compare the teeth and bones that have been unearthed of human beings who lived 100,000 years ago with those of modern man, the differences are less than exist between different individuals at the present day.

With bacteria and viruses there is quite a different state of affairs. Many bacteria reproduce themselves at an incredible speed, certainly millions of generations in a day, and, although we cannot prove it so easily, it is fairly certain that the viruses have a similar ability for rapid reproduction. The evidence of such rapid reproduction in viruses is indirect, since they are invisible, but such diseases as smallpox and foot and mouth disease, which are known to be due to viruses, would be inexplicable otherwise.

It follows that bacteria and viruses are capable of evolving a

new type of variety with far greater speed in terms of time than is possible for their hosts, whether men or animals. We can have no hope of evolving an immunity by natural processes to bacterial and virus diseases, since, even were it possible for man to evolve immunity to virus disease, these parasites could evolve a new variety much more rapidly than any immunity man can evolve to resist their invasion.

It would seem probable—one might almost venture to say certain—that in the future new types of disease due to bacteria and viruses will be evolved, even more deadly to man than those which now attack him. In the race between man and his parasites, especially the virus diseases, it would seem that the former has little chance, owing to the much greater power of evolvement of new types possessed by the viruses, and that man is threatened, if he has to rely upon natural processes alone, by eventual extermination. A similar fate, probably due to the same cause, overtook the great reptiles which for some 200 millions of years lived and flourished on this earth. We can never know exactly how they were exterminated, but it seems most probable that the evolution in time of some parasite able to live upon them and kill them was the cause of their downfall.

The same fate would seem in store for man, unless he can, by the use of his brains, find means of preventing the bacteria and viruses from obtaining an entrance to his body, or of so raising his own immunity by artificial means that he can survive their attack. By such means he has already successfully conquered smallpox, diphtheria and plague, and it is probable that his means of defence will increase more rapidly as time goes on, but the fight will be a never ending one and any breakdown of civilisation such as results from great wars will at once give the virus diseases their chance, with disastrous consequences. In fact, during the last twenty-five years two entirely new diseases due to viruses have been evolved. One of these is pneumonic influenza and the other is Parrot's disease.

By knowledge alone, and its proper application, can man hope to survive in his present numbers through the next few thousand years. That he will do so successfully I have little doubt, but many factors are concerned, among which peace and a properly ordered civil state, which allows scientific knowledge full development, are perhaps the most important.

CHAPTER XI

GROWTH*

WHAT exactly do we mean by growth? Of course when we see a plant pushing its way up from the soil, or a baby getting larger each week, we say it is growing; but how does it occur and what exactly is it that is happening? Curiously enough, though growth is such an interesting and important thing, we do not as yet know very much about it, and until quite recently we knew hardly anything. Had you asked John Hunter, or even Lord Lister, to explain the process of growth, he would not have been able to satisfy you. Now at least we can understand the process, but there are still many, very many, gaps to be filled in before we can know all about it, and there are quite a lot of very puzzling problems as yet unanswered.

What we generally understand by growth is an increase in size. The baby gets bigger and bigger, and the tree gets taller and thicker, but there is a great deal more to growth than that. Animals, such as man, grow in size to a certain more or less fixed size, and then do not get any larger, but for all that growth in them does not stop; it is only the increase in size that stops. Trees on the other hand continue to get larger throughout their whole period of existence.

We say an individual is grown up when he or she reaches the age of twenty-one, by which we mean that he will not get any taller or thicker, though he may, and generally does, get fatter and heavier. But growth has not stopped; it has only reached a certain maximum, and after that is limited to maintaining the maximum at the level which has been reached.

Some of the tissues, such as the brain and muscles, do not appear to grow once the maximum which we call adulthood has been reached, but most of the other tissues continue to grow until death brings everything to an end.

Some tissues in the adult grow quite fast, while others grow very slowly. The hair and nails grow quite fast and have to be cut periodically, while growth in the bones is quite a slow process once adult life has been reached. The amount of growth that

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takes place is exactly in proportion to requirements and is not constant even for the same tissue; it depends upon the amount of destruction or wear that is going on. In the breast of a woman who is suckling her child there is considerable destruction of tissues and growth is rapid, while in a resting breast there is very little growth taking place.

The skin covering the palm of the hand is subject to very considerable wear and friction depending upon the particular purpose for which the hands are being employed. If a person who is not accustomed to manual labour starts digging up the garden, or using any other implement requiring a firm grip on hard wooden handles, he will at first probably blister his hands because he is wearing away the skin faster than it can be replaced; but if he persists the skin on the palm of his hands will soon become thickened to resist the increased friction. Should he then give up digging and resume a sedentary occupation which does not result in excessive friction of the skin of his hands, the skin will in a short time become thinner again as it was before.

This is a good example of the curious manner in which the growth of tissues is controlled so as always exactly to meet the requirements of the individual and yet is able to revert to the normal again when excessive growth is no longer called for.

We do not at present know how this control works, but we believe the mechanism governing it resides in the cells themselves and not in the brain or any other part of the body. It may be that the destruction of one cell stimulates another cell to divide and so replace its lost brother, but the exact manner in which this occurs is still very obscure.

In certain instances overgrowth of certain tissues occurs owing to excessive quantities of some substance in the blood, such as one of the internal secretions or hormones, and in the disease called cretenism overgrowth of tissue results from the absence of normal secretion of the thyroid gland. But there is at present no reason to believe that normal growth of adult tissue is controlled to any serious extent by secretions from glands in distant parts of the body. The control is so exact and so localised that the cells of the tissue concerned must themselves contain the operating mechanism. The process of normal growth, or growth of replacement, has been most exactly studied in the skin, and it is not known how the other tissues are periodically replaced as they wear out, but it is at least very probable that the process is similar.

The skin consists of a great many layers of cells resting upon

a membrane or elastic framework. The cells at the bottom of the skin in contact with this framework are called the basal cells, and it is in these cells that growth is initiated. Every now and then one of these cells splits into two halves. One of the new cells remains in the position of the original cell and replaces it, while the other is pushed forward towards the surface. Each new cell as it is formed progresses slowly outwards towards the surface so that there is a continuous procession of cells outwards from the basal cells. As the cells get pushed farther and farther towards the surface they change their character and appearance. All this can be readily studied under the microscope.

Unfortunately it is not possible to watch the process in living skin, but by cutting cross sections of skin and examining large numbers of such sections all the different steps in the process can be seen.

The cells nearest the basal cells still have a nucleus and a more or less spherical shape, but as they get pushed farther out they become flattened and lose their nucleus. They are no longer capable of dividing and near the surface they are just hard scales which in time are shed off as dust.

It is obvious that if all the basal cells were to divide at the same time it might cause some distortion of the skin, but this is not what happens; division only occurs occasionally and then not in a number of cells in one area, but in different areas, so that at any one time only a few cells will divide in any single area of the skin. It is evident that although one of the basal cells divides into two cells there is no increase of the total number of cells, as the extra cell only takes the place of an old worn out cell that has been thrown off, so to speak, at the surface. The total number of cells in the skin is kept fairly constant.

The growth produced by the division of the basal cells, besides making up for the constant loss of worn out surface cells, has also another function to perform; it has to repair gross damage, as for instance, when the skin is cut, bruised or burnt.

Let us take the case where a small piece of the whole thickness of the skin has been removed, as not infrequently happens to one of us when we cut our knuckles on some sharp object. Let us suppose that a piece of the whole thickness of the skin has been removed right down to the basement membrane, and to simplify matters we will also assume that no septic infection of the wound has occurred. The gap formed by the loss of skin will first be filled up with blood clot. This clot will become quite firm, filling up

the gap and protecting it from the air, and will form what we are accustomed to call a scab. Certain cells from the blood and surrounding tissues now migrate into the blood clot and form a loose scaffolding of fibrous tissue to fill up the gap, while at the same time the basal cells of the skin in the immediate neighbourhood of the injury start to divide into two, but instead of one going forward in the procession they both remain basal cells and pass sideways, so to speak, to cover in the gap. These new basal cells again divide and the process is continued till the damaged area is again covered in over the fibrous scaffolding with basal cells. Then the basal cells, still dividing, form new surface cells to grow forward so that in a comparatively short space of time the gap is again completely covered in with skin; but while this has been happening the fibrous scaffolding which is filling up the gap begins to contract and, as it is anchored to the undamaged skin all round it, draws the sides of the gap together, so that the actual area that requires to be covered with new skin is much smaller than the original injury produced, since the skin is an elastic structure and can be drawn together round the gap.

The deficiency in the skin is thus closed up, partly by surrounding skin being drawn together around it by the contraction of the fibrous scaffolding, and partly by the formation of new cells to take the place of those that have been lost.

All these processes go on at the time until the gap is completely filled in and covered with a new layer of skin. Last of all a large part of the fibrous scaffolding which repaired the gap until the skin had covered it is removed. It is never entirely removed so that there is always a scar, as we call it, left behind; this is the remains of the fibrous scaffolding.

When the gap in the skin is very large the repair is not so good; a large part of the bared area being replaced only with fibrous tissue and a very thin layer of skin cells. The reason for this is that the new blood vessels cannot deal with a large area and a proper supply of the necessary blood to nourish the new skin cells cannot reach them. It is for this reason that when a large area of skin has been removed we have to assist nature by bringing what are called skin grafts from other places to assist in making up the deficiency.

It is surprising, however, what comparatively large deficiencies in the skin can be repaired almost perfectly. I say almost, because the new skin is not quite perfect, since it contains no sweat glands as did the original skin, nor hair glands, if the part was one where

hair grew, and it often contains very few nerve cells; for all practical purposes, however, it is just as good as the original piece of skin that was removed.

In order to restore the damaged part all the cells which are striving to repair the deficiency have to grow and divide much faster than usual, but directly the repair is complete they revert once more to their original rate of growth. In other words, they increase their rate of growth until they get back to the normal but no more. We do not at present know exactly how this beautiful control mechanism works, but it is the same everywhere in the body.

When a bone is fractured we see the same process. A fibrous scaffolding is first thrown out all round the two broken ends of bone and into this dividing cells migrate and start strengthening the scaffolding by making new bone all round the broken ends until the latter are held firmly together by a great mass of bony scaffolding overlapping both the broken ends of the bone.

At this stage the two ends of the bone are firmly held together so that the bone can again function and, if it be a leg bone, the owner will again be able to support his weight upon it, but there is still an excessive amount of new bone, forming an ugly mass at the point of union.

At the same time, but more slowly, the gap between the two ends of the bone is being filled up with new true bone until at last the bone is completely restored to its original shape; this is assuming that the bone remained with the two broken ends in proper position, or was so placed in a splint, that is to say, set properly.

When at last the bone has been properly joined up with true bone the sturdy scaffolding of temporary bone is slowly, but completely, removed so that if we examine such a bone a few years after the break by means of X-rays all we shall be able to see is a faint line where the break occurred, and the bone is as strong as it was before it was broken.

Growth in the winged insects is limited, because the wing of an insect cannot grow, since once formed it is too thin, consisting of a layer only a few cells thick. All growth, therefore, is confined to the caterpillar and chrysalis stages and no growth takes place, or can take place, when the winged stage is reached. Thus the dragon fly, the butterfly and the mosquito cannot grow, and their life is very short when once they have reached their final stage. Some insects spend as much as two years in the early stages, but

when they reach the final or winged stage, they live only a day or two.

The power of growth possessed by some of the minute organisms, called protozoa, is amazing. Such organisms grow by simply dividing into two, but they do this very rapidly. In some instances every one of the minute organisms divides once an hour, so that although they are so minute that they can only be seen under a high power microscope, they would, always assuming that they could find sufficient food, form a mass so vast that it would weigh more than the whole earth inside a week. Fortunately for the other living organisms on the earth such continuous growth is not possible, because they are eaten as fast as they grow. The whole surface of the sea is swarming with various protozoa which form the food of most kinds of fish and is known as Plankton.

The power of growth, or more properly reproduction, of the most minute organisms, the viruses of disease, which cause foot and mouth disease, smallpox, influenza, and distemper in dogs, is terrifying.

But, although they are so small that they cannot be seen by the most powerful microscope, they can reproduce so rapidly that they can kill a man or a bullock within a comparatively few hours; were it not for their power of rapid reproduction they would be completely harmless.

CHAPTER XII

ABNORMALITIES OF GROWTH

IN the last chapter we considered the normal growth of tissue and of the body as a whole, and the manner in which this takes place. But growth is not always normal or properly ordered, and there are many ways in which it can go wrong. It is from the study of cases of abnormal growth that many of the facts about normal growth have been gleaned; for the abnormal cases often reveal to the biologist truths which might otherwise be difficult to ascertain from the study of the normal.

We are all familiar with the dwarfs and giants that are sometimes exhibited in the side shows at circuses. These, of course, are examples of abnormal growth and most of these freaks are accidents, or what are often called "sports." Such accidents have doubtless occasionally taken place ever since the beginning of man's history. The fairy stories and romances of the past all describe giants and dwarfs, and it is most probable that they were not all purely imaginary characters. Gog and Magog, the legendary twin giants of the City of London, were probably real people. The skeleton of an Irish giant may be seen to-day in the museum of the Royal College of Surgeons. He was nearly nine feet high during life, and John Hunter bought his body after death and preserved the bones.

Giants and dwarfs are probably true freaks. It does not appear that giants breed extra large sized sons and daughters, and when two dwarfs have married and had children these children have been normal in size. Such freaks are accidents, due to some abnormality of growth, probably in the early stages, and it is noticeable, at any rate with giants, that they are seldom very healthy individuals, though this does not appear to be the case with dwarfs.

One of the most famous dwarfs was Xit, who was born in 1619. At the age of nine he was under eighteen inches high. He was adopted as a page by Queen Henrietta Maria, the wife of King Charles I, and subsequently became a Captain of Horse and fought for the Royalist cause against the Ironsides.

Another famous dwarf called Richebourg was only twenty-three inches tall and was a servant in the Orleans family in France. It is stated that he acted as a spy during the revolution, passing in and out of Paris as a baby in arms.

The famous Tom Thumb was thirty-one inches high. He lived to quite a good age and married another dwarf smaller than himself.

In certain families the men and women tend to be larger or smaller than the average, but not to the extent we are accustomed to associate with giants and dwarfs, so that the conditions cannot be explained by heredity.

There are, however, certain well-known abnormalities of growth which can be to a large extent explained as being due to an upset of the normal balance through excessive amounts of certain hormones circulating in the blood, or to the reverse condition, when there is not sufficient of such substances.

Normal growth exhibits a wonderful balancing mechanism by which growth continues up to a certain point and then ceases, so that the optimum always remains constant. This applies not only to the growth of the child up to the stage of adulthood, but also to the local growth of tissues to make up for wear or injury.

Occasionally something goes wrong with this mechanism and then there are most peculiar results. It sometimes happens that a child will grow perfectly normally for some years, and then there will be no further growth at all. Such a child will be quite normal till the age of six years or so, and then will remain stationary without any further development. It will remain a normal child of six, although as time passes its age reckoned in years may be thirty or forty. Both mentally and physically such an individual will be a normal child of six, playing with toys and showing the mental capacity and appearance of a child in spite of the fact that it is really a middle-aged individual. Parents often say they would like their children never to grow up, but when this really happens it is a tragedy of the first magnitude.

The parents will be quite elderly people with grown-up children who have married and started families of their own and yet in the nursery there is still a small boy of six who has not altered at all for over thirty years and will never do so. He must always remain a child, with a nurse or someone to look after him, unable to take his place in the world, with no companions of his own level. Such terrible secrets are naturally kept hidden as much as possible, but they are not so very uncommon.

We do not know exactly what it is that has happened to a normal baby to arrest its development suddenly, and at present medical science is quite unable to suggest a remedy.

Some years ago I saw a lady whose age was forty-five; her husband was about fifty, and she had two grown-up daughters. She herself appeared to be a rather immature girl of sixteen or seventeen; she had never become a complete adult and both in

appearance and mentally she had remained a young girl. This was a real tragedy for her husband and for both the daughters, who treated their mother as if she was a much younger sister who had to be looked after and prevented from doing foolish things. Both the daughters looked much older than their mother, and she must have been a poor companion to her middle-aged husband.

The cretins, who used to be so common in certain Swiss valleys and some parts of Derbyshire, were children who had deficient thyroid glands. They looked and were stupid; they remained small and partly infantile, and were quite unteachable; they never developed into full adulthood.

At the beginning of this century it was discovered that the secretion of the thyroid gland, the lack of which in their blood was the cause of the trouble, could be replaced by a substance called thyrotoxin, which is easily administered by the mouth. When this substance was given daily a remarkable change very soon came over the cretins, who began to develop in a normal manner. They became intelligent instead of stupid, they became energetic instead of lazy; their ugly appearance disappeared and the children began to grow properly. In fact they became and remained normal individuals so long, but only so long, as they could be kept supplied with the drug. For the rest of their lives they were obliged to take daily doses of thyrotoxin.

Such cases still occur, though less frequently because the cause is now known to be due to a water supply containing insufficient iodine and this can be corrected. Thus there are no longer true cretins in areas where a knowledge of modern medicine is available.

The reverse condition is also sometimes seen where the child grows up at quite an abnormal rate. There was a King of Bavaria who developed so rapidly that he was married at the age of ten and died a senile old man at the age of twenty-two.

Some of these curious cases are due to a tumour in the adrenal gland, and if the child is operated on and the tumour removed, the child reverts to his or her original condition and becomes once more normal for his age.

A most extraordinary condition is sometimes seen in children, where one side of the body is growing faster than the other side. The condition is completely bilateral so that every structure on one side of the body is slightly larger than the other. One side of the face is larger than the other and looks older, and the child

cannot walk properly without having a high boot on the foot of the short side; one hand is larger than the other and the arm is longer. The child grows into a curve because one side is longer than the other.

A boy was shown at one of the medical societies of London some time ago who was two and a-half inches longer on the left side than on the right.

How this curious condition arises we do not know. Several of these children have been kept under observation for many years. They continue to develop normally except that one side of them keeps ahead of the other. What ultimately happens when they reach adult age is still uncertain, but it appears that the short side eventually catches up so that as adults they become normal.

It is difficult to explain such cases as this satisfactorily. They suggest that when the original first cell in the fertilised ovum divided something happened which delayed the growth of one of the resulting cells, so that the other cell had some advantage which enabled it, and all its daughter cells, to get slightly ahead in the race. But it is difficult to conceive exactly how this could have happened.

A scientist who is a friend of mine, and much interested in genetic problems, told me that some years ago he was walking on the sea-shore at Hong Kong when he came across a Chinese baby playing naked in the sands. The baby was half white and half coloured; the right side of its body being coloured and the left side white. He was so struck by the baby's extraordinary appearance that he made friends with it in order to make a closer examination. There was no doubt about it at all; it was not a question of dirt or anything of that kind. The baby was quite normal except that the right side was negroid in colour and the left Chinese.

One of the baby's parents must have been a negro and the other Chinese, but by some extraordinary chance during the first division of the fertilized ovum from which it had developed, the negroid characters as regards colour had got into one side only.

My friend was so intrigued with this curiosity that he tried to purchase the baby from its Chinese mother, but in this he was unsuccessful.

We know that very extraordinary things can happen during the first few divisions of the fertilized egg, but we do not at present understand them. True twins are produced in this way.

At the first division of the fertilized ovum each half of the egg becomes a separate individual and continues as such ever afterwards. Such twins are always of the same sex and they are so exactly alike that they cannot be distinguished apart, even by their own parents. One of them is always sterile, because the sex chromosome is single, and only one of them, therefore, can inherit it.

This is known to farmers who, when they find that one of their cows has given birth to identical twins, generally destroy both calves because they know that one will be unable to breed and there is no means of finding out which of the two it will be.

Of recent years true twins, or as they are called, monozygous twins, have been a source of great interest to biologists, because they afford a means of studying genetic problems of inheritance.

Since both twins come from the same single fertilized egg it follows that both have inherited identically the same characters from each parent. It is for this reason that they are so alike both in appearance and in mental attributes. Many cases have been recorded where both twins have passed school examinations at the same time and with almost the same marks. Such twins afford an opportunity for the study of individuals with an identical physical and mental make-up, and psychologists have made exhaustive investigations into their reactions to various mental and emotional stimuli.

Another most remarkable fact about these twins has been observed; namely, that they tend to suffer from the same diseases at the same time, and to react to such diseases in the same manner. This is, of course, not really so odd since both twins are exactly alike in their resistance to, or their lack of resistance to, any particular disease.

A fact, however, which is very remarkable, and has caused great interest, is that if they develop a tumour of any kind it is found that both twins develop the same kind of tumour in the same part of the body, and at the same time. Some thirty cases were recently collected of identical twins who had developed tumours, and it was found that in every case both twins had a tumour of the same kind, in the same place, within a few months of each other. From this it is argued, not without good reason, that there is an hereditary factor of some kind in regard to the formation of tumours, though it probably is only a susceptibility for a tumour to develop in a certain tissue at a certain time.

Whenever one of the twins has a birth mark or any kind of

abnormality, it is found that the other twin has an identically similar one on the same place.

One would suppose that since the twins have been produced by the splitting in half of a single egg, that they would be what is called "mirrors" of each other. That is, that one would have his single organs, such as the heart and liver, on the opposite side to the other, and that any defects, such as birth marks, would also be transposed in one of the twins, but as a rule, such is not the case.

In a few instances this has been observed, one twin having the heart on the right instead of the left side, and the liver on the left instead of the right, but the proportion of cases where one twin is a mirror image of the other twin is very small, whereas we should have expected to find that it is the rule.

These cases of identical twins are of very great interest and are now being very carefully studied, as they afford a useful means of discovering the relative importance of heredity and environment in the development of human beings. Since in such twins we know that the effect of heredity in their development is the same for both, it follows that their individual differences, if any, when they reach adult life, must be due to their surroundings and the influence of other persons upon them. They afford, in fact, a most valuable means of investigating many biological and genetic puzzles.

Unfortunately, perhaps, such true twins are rare in the human species, though apparently that strange beast the armadillo normally gives birth to identical twins.

Abnormal growth sometimes affects only certain parts of the body and not the whole. There is a curious disease which is known to be due to a tumour in the pituitary gland, a small gland about the size of a hazel nut situated on the under surface of the brain.

As a result of this disease the skull gets larger, due to thickening of the bone, the nose and upper and lower jaws are also affected in the same way, also the hands and feet. The disease is progressive, but the increase in size is very slow, extending over many years. The head becomes enormous and the face grotesque, with a great protruding nose and heavy cumbersome cheeks which almost obscure the eyes and mouth. The hands become huge and gross and look like some animal's paws.

The unfortunate victims in course of time become so repulsive in appearance that they cannot go out of doors without attracting

immediate attention and even their own relatives can hardly bear the sight of them, so they are frequently obliged to live a lonely life in their rooms, with the blinds drawn and the light reduced to a minimum.

A man who was the victim of this disease was at one time exhibited in the Whitechapel Road as "The Elephant Man" and the late Sir Frederick Treves wrote a story about him.

No means of treating the condition has been discovered. It is believed that removal of the pituitary gland would cure the disease, but as this gland appears to be essential to life and when it has been removed in animals has resulted in their death, it does not seem a feasible or justifiable procedure.

There are many aspects of abnormal cell-growth of which we at present know very little, but which may prove of the very utmost importance in the future. Any single cell of the millions that go to make up the human body grows, that is reproduces itself, by dividing into two cells, only at set times and in exact proportion to the requirements of the particular part of the body to which it belongs. When, as the result of excessive wear or accidental damage, repairs are necessary, then the cell will become more active and divide more frequently, and on the other hand when the part is at rest and inactive then it will divide at longer intervals according to requirements. This is the normal manner in which any basement cell, that is an active cell, behaves; but there are exceptions.

Occasionally, especially in old tissues in elderly people, one single growing cell begins to divide at an excessive rate, quite out of proportion to the cells around it or the requirements of the body as a whole. When this happens a tumour or cancer results.

The single cell starts off in a wild burst of growth, continually dividing, and each of its daughter cells doing the same thing, with the result that after a time a colony of these rapidly dividing cells, which are the progeny, so to speak, of the original cell which started misbehaving, is formed in the middle of the other normal cells that are dividing at the proper times and in the normal manner.

Such an island or colony of rapidly dividing cells forms a tumour, which, as it continues to grow, pushes aside the normal tissues and organs and causes eventually serious embarrassment to the whole body and ultimate death of all the cells.

We do not know what causes one cell suddenly to behave in this manner. It is believed that a change has occurred in the

nucleus of the cell similar to the changes which have from time to time taken place in the germ cells and have resulted in the evolution of species and varieties of living organisms.

Just as a sudden change, or mutation as it is called, may take place in the nucleus of a germ cell, which will result in a deformity or other abnormality being passed on to a succeeding generation of that germ cell, so a similar change in the nucleus of a somatic or fixed body cell will result in the change being passed on to all the progeny of that cell.

Once the change, whether it be for behaviour, form or colour, has taken place, it is permanent in the progeny of that cell.

What are the causes for this change we do not know with any certainty, but some of them are known. Thus the change can be induced artificially almost at will by the application of tar and by certain chemical substances. It can also be induced by X-rays and radium, and ultra violet light, but none of these are what may be called normal causes, and there must be many others about which at present we know little or nothing.

A great deal of most careful research work is now going on with the object of discovering these causes and investigating the manner in which they operate to cause the change in the nucleus of a cell that results in excessive, uncontrolled growth.

In time, no doubt, this research work will succeed in discovering the causes which bring about tumours and, what is of greater importance, some means of preventing them, or a means of reversing the change.

There are many other instances of local over-growth of certain cells in the human body which upset the normal balance. The blood which continually circulates through the body is composed of vast numbers of single, independent cells of different kinds. The proportions of these single cells bear a fairly constant ratio to each other under normal circumstances.

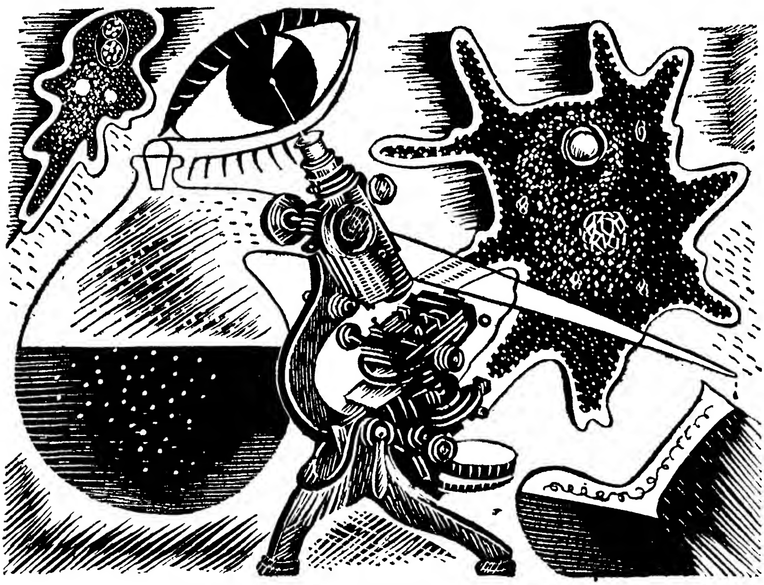
Thus the red corpuscles, whose function is to carry oxygen from the lungs to the tissues, number about five million in every three drops of blood. This proportion of red corpuscles varies very little throughout life. It is reduced as the result of hæmorrhage (bleeding) and after severe illness, resulting in a condition called anæmia, but the proportion soon restores itself to the normal again in much the same manner as a cut in the skin is restored, namely, by increased rate of growth of the blood-forming cells in the bone, marrow and spleen.

There is, however, a curious disease with the rather cumber-

some name of "Polycythemia Rubra" in which the red cells are produced with excessive rapidity, so that the blood contains double or treble the normal proportion of red blood corpuscles. This disease causes grave illness, and eventual death.

Again there are other diseaes called "the leucæmias" where the white cells are produced at an excessive rate, and are found in the blood in abnormal proportions, crowding out the other cells and causing the death of the patient.

These curious blood diseases are caused by a similar process to that which produces cancer, and may be described as cancer of the blood-forming cells.



CHAPTER XIII

FOOD

An adequate supply of food is, and always must be, the first consideration among all living things. Without sufficient food death is inevitable and merely a matter of time. The urge to obtain nourishment is the greatest and most imperative of all urges and is common to all living matter. During those periods when food is of necessity scarce animals have adapted themselves to the circumstances in various ways. Some animals such as the dormouse, the hedgehog and the tortoise go into a condition of hibernation. They fall asleep and remain in this condition, barely alive, living on their own fat, until the spring comes round and a suitable food supply is again available. Others migrate, often long distances, as the winter approaches, to return when conditions are once more favourable.

Many birds fly vast distances on the approach of winter to countries where they are assured of finding food.

The sheep of the Himalayan steppes accumulate fat in their tails as a store which can be drawn upon during the worst periods of winter when grass is scarce and difficult to find. The humps of the camel and the dromedary are similar stores of food, which can be called upon as an emergency ration when the normal supply fails.

Man in the early days of his existence must have been hard put to it to obtain sufficient food. He had to depend upon fruit and berries, and such small animals as he was able to capture or kill with the very inadequate means at his disposal. Until he discovered how to make himself bows and arrows, and flint-tipped spears, the hunting of wild animals must have been a very precarious occupation. Even when he had discovered fire and how to make use of it for cooking and for protecting himself from the larger mammals, he could only ensure an adequate food supply by continuous hunting, and must have been obliged to live the life of a nomad, constantly following the herds of animals upon which his living depended. It was not until he discovered how to grow successive crops of edible grain, by means of tilling and planting the earth, that he was able to remain in any one situation for long periods or to form communities of his fellows.

All the civilisations of the world as it exists to-day have been founded upon agriculture and the harvesting of crops of grain and rice, which can be accumulated in suitable store houses.

Man has now learnt how to store for long periods, not only grain but animal food, by means of tinning and cold storage, and adequate supplies of food are available in all civilised countries. But even to-day as the result of war and a breakdown in the means of transport whole communities may die of starvation.

In Central Russia during the famine of 1921-2 it was estimated that over two million of the inhabitants died more or less directly from starvation and as a result of the late war, starvation is threatened in large parts of Europe and Asia.

Man can live on the germ of plants, the sugar of many fruits, and upon meat and fat. He is not a purely carnivorous animal,but a mixed feeder, being able to keep fairly healthy upon some nuts and fruit, and quite healthy on a diet of grain, that is the seeds of plants, but he can make little or no use of green food, as do the herbivorous animals, such as the cow, the sheep and the horse.

The herbivorous animals have their intestines specially adapted to extracting the nourishment from cellulose. Even then

they would starve, but for the fact that their intestines contain large numbers of certain bacteria which are able to break down cellulose.

Pure cellulose, as it exists in wood, is of very little use to even the herbivorous animals, who can only digest it in the green state, as shoots and leaves.

The termites, or white ants, have got over the difficulty of digesting wood by a most curious arrangement. As is well known they eat wood and are a most serious nuisance in consequence, as they destroy wooden houses and furniture, and in those parts of the tropics where they abound the legs of tables have to be stood in pannikins of water to prevent the termites from attacking the wood. Their intestines are not long enough to extract all the nourishment from the wood they eat, so to get over this difficulty they eat each other's excrement, and by repeating this process all the nourishment that can be made use of is thus extracted from the wood fibre.

Man cannot break down or digest cellulose in his intestines, or only to a very slight extent, and would die if he could find no other food than grass or leaves. If he can discover how to convert or break down cellulose into carbohydrates by some chemical or other process, he would become to a large extent independent of agriculture and his available food supplies would be enormously increased.

He has hitherto been dependent upon the seeds of plants, such as wheat, barley, rice and pulse for his supply of carbohydrate food, but the time may come when he will be able to produce all the carbohydrate food, such as sugar and bread, directly from raw cellulose without the necessity of growing crops by tillage.

As cellulose exists in vast quantities almost all over the world in the form of wood or vegetable matter an adequate supply of the necessary raw material is everywhere available, and if a means can be discovered for converting it into carbohydrates in a suitable form for human consumption every centre of population could be ensured of an adequate food supply that is independent of transport from some distant country. Even on the edge of the Arctic Circle, where agriculture is impossible, there is plenty of timber from which supplies of cellulose could be obtained. Already paper, silk, and wool are being manufactured direct from raw cellulose, and it is even now possible to convert cellulose into starch and sugar in the laboratory.

It will probably not be very long before a process which can be worked commercially will be perfected for the production of sugar and starch direct from raw cellulose; and when this happens the synthetic product is certain in time to replace the agricultural product.

It may be that the process will be a direct chemical synthesis, or it may be that the breaking down of the raw cellulose and its conversion into starches and sugars will be carried out by the aid of bacteria. There is, of course, nothing new in such an idea, as this is the way in which the herbivorous animals, such as the cow and sheep, now convert cellulose into food by means of the bacteria in their alimentary tract, and a process that normally takes place within an animal should be reproducible outside the animal body if the same bacteria can be harnessed to the job.

One of the great advantages of producing carbohydrates, starch and sugar by conversion or by direct synthesis from cellulose is that the raw material, cellulose, can be very readily transported and stored in the form of soft wood, and all the carbohydrate food required by any community could be manufactured, so to speak, on the spot. Cellulose either in the form of wood or vegetable matter exists everywhere, and the supply is almost limitless; thus no large centre of population need be dependent upon some other distant country for its main source of food supply.

The successful exploitation of synthetic carbohydrates would have rather curious repercussions, as it would do away to a large extent with agriculture. Just as the discovery of the aniline dyes destroyed the indigo trade and the production of artificial silk is destroying the silk trade.

The production of carbohydrate food in factories will enable the population of the world to still further increase, and the density of population in favourable areas to be enhanced.

Professor Raymond Pearl has calculated that there are at present 40.9 human beings per square mile of the land area of the world. When we consider the thousands of sqare miles of land which are practically uninhabited, this is an amazing figure, and makes one wonder where it will all end and ask oneself the question—is man's object to see how many human beings can be crowded on to the land surface of the world? If, indeed, this is his object, at least he seems to have a fair chance of ultimately finding out, but that the result will be to the ultimate benefit of the human race seems doubtful.

An adequate food supply is the one factor which at present controls population both as regards total population and density of population in any particular area, and any discovery which increases the food supply must as things are at present directly result in an increase in population. The more food there is, the more people will there be to eat it.

But the feeding of large populations depends very largely upon proper and adequate sea and land transport and upon no serious interference with the supplies of labour necessary to till the soil and harvest the crops. This was demonstrated in the late world war. The mass sinking of ships carrying food to England threatened to starve these islands and produced a very serious shortage of all essential foods, and the enlistment of farm labourers to swell the ranks of modern armies of both the Allies and the Axis has resulted in an almost universal shortage of most of the food supplies in more than half the world and threatened millions with starvation.

CHAPTER XIV

DIET

WHAT do we mean by a diet? It is an expression we are constantly hearing, and not infrequently reading about in the newspapers. A diet, I suppose, is the food that we eat, but rather more than that is implied in the phrase; it means the quantity and composition of the food we eat, and when a person says he is on a diet all he really means is that he is eating food; of course if he were not he would very soon die, but what he intends to imply by the statement that he is on a diet is that both the quantity and the kind of food that he is eating is definitely fixed either by himself or by someone else for him.

There are all sorts of diets; some have been invented by famous physicians, some by mendacious quacks, others by health cranks, or Government departments. Quite a number of diets have got names, such as the X diet or the Y diet, and are given in detail by some of the daily newspapers; while whole books have been written about some of them and there are institutions specially equipped where people can stay and be fed on one of these diets.

There are special diets for prisoners and penal establishments. The objects of such diets is economy and a low energy output, so that the prisoners will not become too uppish and attempt to break out or make trouble. In the old days prison diets contained barely enough nourishment to keep body and soul together, which tended to save trouble in looking after the prisoners and at the same time saved money on the ingredients. Salted pork, rough biscuits and dried peas were the main constituents. To-day such diets, though kept on the low side from an energy producing standpoint, are properly balanced as regards ingredients and contain the proper amount of vitamins.

Then there are diets especially adapted for the use of troops, both in peace time and when in camp, and during war conditions. Ease of transport and cooking are important considerations which have to be considered, while the quantity and ingredients must keep the men in the best possible condition in cold, heat and damp, such as may be experienced under war conditions. Variety has also to be taken into account, as, however good a diet may be, men soon get tired of it if it is always exactly

the same. It was found that the diet served to the troops in the late war was, on the whole, very satisfactory.

Standard minimum diets for crews of merchant ships are now enforced by most Governments, and the old days when the forecastle hands were given weevily biscuits and salt junk are no longer possible.

The six years of war that we have just passed through resulted in everyone who was not in the armed forces being put on a diet, in the sense that the amount and selection of available food materials were limited by a system of rationing. Although the system was unpleasant and uncomfortable, it must be admitted that in this country it worked well on the whole, and many of the population have remained in good health.

As a matter of fact medical science has not reached the page in the book of knowledge where it is possible to say with certainty which particular ingredients in a diet are important and which are not, or where it is even possible to understand the exact way in which the food consumed by an individual is converted into energy or put to store. In time, no doubt, the laws governing the manner in which food is converted into the vital body juices will be an open book, but this is very far from being the case to-day and even the most expert scientist, or the most experienced physician, knows little more than the merest outlines of the problem of dietary.

There are, of course, certain diets which are based upon definite scientific truths and are the result of exact knowledge of the body processes which they are supposed to control. As an example one may cite the diet prescribed for patients suffering from diabetes, where the amount of sugar that gets into the blood stream is in excess of what it should be and can be controlled by the amount of starch or sugar in the food eaten. The results of alterations in such a diet can be checked by exact analysis of the blood sugar, that is the amount of sugar in the circulating blood and the sugar that gets into the urine; and there are one or two other examples of what can be achieved by carefully controlled dietary, but there are not many.

Most of the popular diets prescribed at the present day are intended to result in a reduction in body weight or the reverse. The most popular diets are those which are designed to reduce body weight, because it is now fashionable for women who want to look attractive to have a svelte figure with narrow hips and flat breasts. A good looking full bust and wide full feminine hips

are not considered "de mode." A flat almost hollow figure is supposed to be the correct thing. As this type of female figure is not natural for women who have passed their youth, it can only be achieved by considerable sacrifice and a certain amount of deprivation of one kind or another.

There are many different kinds of individuals in this world. Some can eat as much as they like and they will never get fat, while others will put on weight, or so it would seem, even if their diet were to consist of air and water. As a matter of fact most of those people who get fat are very fond of their food and do not like exercise. They are lazy, unenergetic people, while thin people are usually very energetic and indifferent about their food.

It does not require the brains of a scientist to conclude that the fat people will get thinner if they eat less and take more exercise, and thin people will get fatter if they take less exercise and eat more food. A very obvious and common sense conclusion, but it would appear a very unpalatable one.

Most people do not like the plain truth, they like it wrapped up very carefully in formulæ, and they generally get what they want.

All the so-called diets which are prescribed for reducing the weight of people who want to get thinner are founded upon two main principles. One is to give them food which is deficient in nourishment and the other is to reduce the actual amount of food.

The most popular method is the first because it does not involve any real hardship for the individual concerned. He, or she (and it is generally a she), can eat as much as she likes, or in these days as much as she can get. The food is appetising and filling; she has not got to leave the table feeling she has not had enough to eat. Such diets are quite bulky, but consist of material which is of very little value, such as straw, gelatine, the undigestible parts of vegetables and fruit, with, of course, suitable flavourings to make them appetising.

Such diets hardly contain enough nutrient material to keep a healthy mouse alive, but they have plenty of bulk and consequently are satisfying in that they fill the stomach and assuage hunger. The individuals on such a diet will lose weight without being obliged to feel unduly hungry and with little distress to themselves, and are consequently very pleased with such a regime.

This particular form of dietary has to be carried out in some

institution or spa where special arrangements can be made for its preparation and in the past was a very paying proposition for those who ran such institutions, as the cost of such food, apart from its preparation, is quite trivial.

The other form of dietary for reducing weight has at least the advantage of being honest, as it consists of radically reducing the amount of food eaten. But as very few people have the moral courage in cold blood to reduce their meals to the necessary extent, and for sufficient time to be effective, a prescribed diet is more popular. The idea consists in living for a fortnight or three weeks upon a few oranges and three glasses of lemonade each day. The feeling of hunger passes off after a few days and the loss of weight, especially if moderate exercises and massage are also part of the regime, is often quite spectacular. Of course, this is not a diet at all; it is the absence of one. But the results are somewhat startling and it is extraordinary what a number of people are willing to put up with the discomfort and inconvenience involved. It is always pleasanter to starve oneself in company than alone, and such dietary regimes are for that reason most effective in institutions specially designed for the purpose.

There is, as a matter of fact, no mystery about reducing weight. All that is required is to eat less food of all sorts and if this is persisted in the individual will lose weight certainly and inevitably, but the ordinary individual does not like to think in such plain language and prefers to have the facts camouflaged under the name of a diet taken from a book, a newspaper article, or prescribed by some famous physician. But it all comes to the same thing in the end.

As a matter of fact the human stomach is capable of dealing with a quite amazing variety of constituents, and extracting from them all the nutriment that they contain without the individual to whom the stomach belongs being at all inconvenienced. Of course it draws the line at tintacks and completely indigestible matter, when in excess, though it is an extraordinary fact that it can deal quite efficiently with a reasonable number of tintacks and other queer oddments.

We hear a lot about vegetarian diets and how good they are for some people; how they provide vitamins which are missing in most diets and so on.

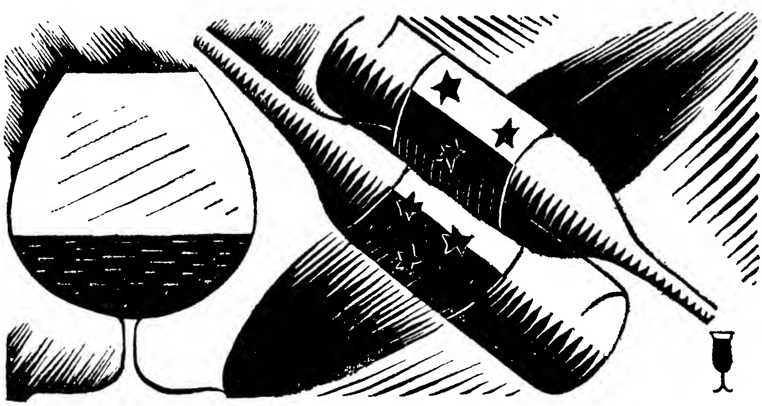
The truth is that while the absence of vitamins seems to affect growing children very considerably, there are very few cases

where there is any evidence of adults being affected by their absence. Also while one way of obtaining a full supply of vitamins is by stuffing oneself with raw fruit and vegetables, there is no getting over the fact that one or two drops of artificial vitamins, which can now be bought at any chemists, will do as much good as a cartload of fruit and will be much cheaper.

As a matter of fact there are no real vegetarians, and any human being who really tried to live on green food only would very soon die, as the human body is quite unable to obtain the necessary nourishment from vegetables alone. Of course all vegetarians eat eggs, cheese and milk none of which can by any stretch of imagination be considered vegetables. There are no really honest vegetarians, because they all die off early, or become ill and are put on more reasonable diets by their medical advisors.

Of course, there are a great many people who habitually eat too much and such persons benefit very considerably by being put on a vegetarian diet, because, while they probably eat more they get much less nourishment, and so do not damage their tissues by overloading them with an excess of food substances.

Far more people die from overeating in the long run than from excessive drinking. Alcohol is, of course, itself a diet and a very valuable and easily administered diet. Many very old people have discovered this and one not infrequently comes across some old lady or gentleman who to all intents and purposes is living on alcohol. The old gentlemen generally admit it quite



frankly, but the old ladies are much more naïve. They generally assure those about them that they just have a small liqueur glass

of brandy occasionally when they are feeling faint. But I remember one such old lady who consumed a good two bottles of liqueur brandy a day. There was no doubt that this was what kept her alive and for some years she lived mainly on brandy.

There are some kinds of food which are quite poisonous to certain individuals. Some people cannot eat mushrooms in any form without being violently ill, others cannot eat shell fish without coming out in a rash, or strawberries without getting an attack of gout; but such cases are exceptions and have nothing to do with diet.

Some people imagine that tinned food will make them ill, but are quite unaware that they are probably eating tinned food frequently without knowing it. Men on expeditions to the Poles, or in the desert areas, have lived on tinned food for months, even years, without any deterioration in their health.

The amount of food consumed should bear a close relationship to the amount of energy expended. That is to say, a man who is doing strenuous work will require more food than one who is leading a purely sedentary life. You could not make a vegetarian out of a farm labourer, because he would become ineffective in doing heavy work, and would soon lose his job; but such a diet is quite all right for poets and lady novelists.

Unfortunately, the person living a sedentary life too often likes his food and does not realise that with less exertion he requires less food, or at least less nourishing food.

The amount and the quality of the food we eat should be adjusted to the amount of energy expended. Muscular energy causes the greatest expenditure of food substances and necessitates a full and nourishing diet. This fact is, of course, well known.

Next to this comes exposure to cold and wet. The amount of energy required to maintain the body temperature at the proper level in conditions of extreme cold calls for a good nourishing diet.

Everyone knows that in the very hot weather one feels better on a very light diet, and that in very cold weather good meals are the right thing.

Very small animals, such as mice, require to eat three or four times as much food in proportion to their weight as we do because, owing to their relatively large surface compared to their bulk, they lose more heat in a given time than a large animal, such as a man.

What we call brain work also causes considerable loss of energy,

which has to be made up by food, but the consumption of energy is not comparable with that used up by prolonged muscular exertion, or in keeping warm in cold weather. At the same time a person who is insufficiently nourished will not be able to use his brain to advantage, and the quality and quantity of his output will soon begin to suffer, if he is starved.

People who suffer from indigestion always think that what they require is a special diet. Most persons arrive at what they think is a good diet for themselves by a process of eliminating all those foods which they find from experience give them pain, while others have more belief in going to a doctor and getting him to prescribe a special diet for them. Most forms of indigestion, however, are not due to eating unsuitable foods, but to there being something wrong with the process of digestion.

There may be too much of the digestive juices or too little, or something else may be wrong. The best way of dealing with indigestion is to find what is wrong and correct it. When this has been achieved the individual will again be able to eat ordinary food and a special diet will not be necessary.

Unfortunately, it is not always easy to find out exactly what is wrong, but in this respect medical science is improving very rapidly.

There are fashions in diet just as there are in ladies' dresses and they vary from year to year, and from one country to another. Fortunes have been made by selling patent kinds of bread, biscuits and cereals for invalids or pseudo invalids. Most of these substances are very poor substitutes for real bread, which can be bought much cheaper and fresher at the baker's; but the well-advertised and inferior article at a higher price commands a ready sale and will continue to do so until human beings have become much more sensible than they are at present.

Artificial methods of preserving food, such as cold storage, tinning, bottling and drying of food stuffs now make it possible for the ordinary individual to obtain good nourishing food all the year round. But some hundred and fifty years ago there was a real shortage of suitable food during the winter months. Cows gave no milk after the green meadows gave out because there were no artificial foods, such as linseed cake, mangels, etc., to keep them well fed. As a consequence the children had to go without milk as there were no artificial substitutes or preserved milks, and as a result the children in those days were very poorly nourished as compared with the children of to-day.

The winter months were a period of restricted food, almost of real starvation, for very large numbers of people until quite recent times. A sufficient diet for the whole year is a blessing which in these days is not appreciated as it should be by those who have never known what it is to go hungry, not because they wanted to lose weight and improve their figures, but because there was not enough for them to eat.

In the old days children who were no longer at their Mother's breasts were fed on pap (bread soaked in water) as a substitute for milk, or on oatmeal and water. They managed to survive, but there were in those days very many rickety children; and owing to the fact that the children were underfed during a large part of their growing period our ancestors were as a whole smaller than we are to-day. No normal modern man can get into any of the armour which our ancestors used to wear.

The Feast of Christmas, which we still keep up, is a relic of the days when the winter months meant partial starvation. Special foods were obtained, animals were killed and a very special feast of food was indulged in at Christmas time, and must have made a very pleasant and welcome break in the long, cold, foodless winter.

CHAPTER XV

ALLERGY

THIS is a comparatively new word which has hardly yet found its way into the dictionaries and could not fairly be used in the construction of a crossword puzzle. Yet it describes a condition, or phenomenon, of the very utmost importance to all human beings, and when the science of medicine has successfully disentangled the knots and tangles a whole series of distressing diseases, which at present cause suffering and illness to many, will disappear.

Allergy may be defined as a condition of hypersensitivity to a foreign protein. Proteins are chemical substances produced in the bodies of animals and plants; in other words, in living things, and are the essential factors of living, as compared with non-living, substances.

All living things, both vegetable and animal, are composed of protein. Protein can be analysed and we know of what inorganic substances it is composed; but no chemist has as yet succeeded in synthesizing protein. Although we know of what it is composed, we cannot make it out of inorganic substances.

The average composition of proteins is carbon 51 per cent, oxygen 25 per cent, nitrogen 16 per cent, hydrogen 7 per cent, sulphur 0.4 per cent and phosphorous 0.4 per cent.

The curious phenomenon that is called Allergy is due to the interaction of different proteins upon each other. To illustrate this, if the serum taken from horse's blood, that is, the clear part of the blood without the red corpuscles, is injected with a hypodermic syringe into a man nothing particular will happen, but if some time later another dose of horse serum is injected into the same man it may cause most alarming symptoms and cause his death in a few minutes.

This fact is of great importance, as serum prepared from horses is used as a means of curing or preventing many diseases, such as septicaemia, pneumonia, scarlet fever and tetanus.

During the Great War of 1914-1918, many of the wounded soldiers in France got tetanus owing to infection of their wounds

with tetanus bacilli from the soil in Flanders, and to start with there were many deaths from this cause, until a rule was made that every wounded man must be given an injection of anti-tetanus serum directly he came into a hospital. This proved completely successful in preventing the onset of tetanus, and was undoubtedly the means of saving a great number of lives.

This anti-tetanic serum was prepared from horse serum and one of the effects of the injection was to make all the men who had been wounded hypersensitive to horse serum in any form, so that if for any reason more anti-tetanic serum, or any other form of serum made from horses, was subsequently injected into them there was a grave danger of producing most alarming and dangerous symptoms. After several such accidents had occurred it became known that horse serum must never be injected into any soldier without first finding out if he had been injected with the serum before.

This curious hypersensitivity to horse serum is not permanent, but may last for many months. It is known among doctors as anaphylaxis.

The real interest of this allergic phenomenon, however, concerns its relation to certain well-known diseases, such as asthma, hay-fever, urticaria, etc. Certain individuals inherit from their parents or ancestors an excessive hypersensitivity to certain animal or vegetable proteins, and when anyone who has been so unfortunate as to have inherited this tendency comes into contact with the particular protein to which he is hypersensitive he suffers acute distress.

The actual quantity of the foreign substance may be so little as to be quite unmeasurable, and may be in what he eats, drinks, smells or breathes, but the result will be the same: he will be seriously poisoned for some hours. It is obvious that if the person knows what the particular poison is that affects him, all he has to do is to avoid any contact with it, but unfortunately he is usually quite unaware of the nature of his particular poison, or is quite unable to detect its presence until it is too late.

I remember vividly a particular instance of this. There are some persons who have inherited an extreme hypersensitivity to fish in any form. Now fish is a very common article of diet and such individuals must soon become aware of the fact that under no circumstances must they eat fish, but in a modern restaurant one does not always know what one is eating. I had a young officer upon whom I had to perform an operation and in the course of

my attendance upon him he informed me that he could not eat fish of any description without most distressing symptoms, and that he always took great care to avoid eating it.

A month or so after he had passed out of my care, he got married and came to stay at a well-known London hotel for his honeymoon. One night, while he was dining with his wife in the restaurant she suddenly noticed that her husband looked very ill. His face had swollen, his tongue was hanging out of his mouth, he could not speak and he seemed to have great difficulty in breathing. She was naturally very alarmed and could not imagine what had happened to him, as he had been quite well only a few minutes before when they had sat down to dinner and they had only finished the soup when he became ill. She suggested getting a doctor, but she had not lived in London and did not know what to do. She remembered, however, that her husband had recently been under my care, and she helped him out of the hotel into a taxi and they drove straight to my house. Fortunately I was at home and was able to see him at once. He was a most distressing sight and it was not surprising that his young wife was frightened. His face was all swollen so that his eyes were almost closed, his tongue was hanging out because it was too swollen to keep inside his mouth, and he was breathing with great difficulty owing to the fact that his throat was swollen.

Fortunately I knew at once what was the matter, and when I asked him if his trouble was not due to his having eaten fish, he nodded his head.

He looked so bad that I thought it possible I might have very quickly to perform a tracheotomy, that is, open his wind pipe, to prevent his dying from suffocation, but after watching him for about ten minutes I realised that the acute symptoms were passing off. His breathing was becoming easier and at the end of twenty minutes he could get his tongue inside his mouth and could speak reasonably well. He told me he was sure there had been shrimps in the soup he had taken at the restaurant and that they had caused the trouble. I kept him in my consulting room until the worst of his symptoms had passed and then sent him back to bed. I expect his wife has been very careful ever since that her husband never has fish in any form.

The disease called asthma is due to allergy and it is often difficult or impossible to discover what the particular protein is which causes the attacks. Doctors are well aware that asthma is due to some foreign protein to which the patient is unduly

sensitive, and take great trouble to try and ascertain its nature and how to protect the patient from it. If the cause can be discovered it is even possible sometimes to desensitize the patient by means of inoculations and prevent the attacks. The trouble is that it is often extremely difficult to find out what particular protein is the cause of the symptoms.

One of my relatives suffered from asthma so severely as a child that his parents doubted if he would ever survive. However, after he went away to a preparatory school at the age of twelve years he ceased entirely to suffer from asthma, although the explanation was not discovered until many years later. At that time it was put down to the change of air.

The real explanation was that my relative was hypersensitive to linseed and when he was a child it was the custom to put linseed poultices on the chest of anyone who had a cold. As a child whenever he had the sign of a cold on went a linseed poultice, with the result that a severe attack of asthma immediately developed calling for more and more linseed poultices, so that he went from bad to worse. When, however, he went to school linseed poultices were not used and consequently he had no further attacks. Years afterwards he himself discovered that even if he went into a room where a linseed poultice had been, or into a granary where linseed was stored, or near cattle who were eating linseed cake, he immediately got a mild attack of asthma. So sensitive is he that he can detect certain cheap brands of whisky in which linseed has been used as a substitute for barley.

The commonest form of hay fever is due to the pollen of plants. When the grasses are reaching maturity they begin to seed, and the dusty pollen grains are blown in the wind and are breathed into the nose of anyone in the neighbourhood.

In sensitive persons the fine pollen grains, which consist of plant protein, cause an acute attack of asthma which keeps on recurring as the different grasses and plants seed at different times, so that asthmatic subjects are made quite ill during the early summer months and, as the pollen grains have a very wide distribution, they cannot avoid being affected except by going to sea.

I know several sufferers who now always go on a long sea cruise during that part of the early summer when they know from past experience that they will inevitably suffer from asthma if they stay on land.

The most curious cases are those in which a person has

inherited an acute hypersensitivity to horses or cats. Apparently the smell of a horse, or the mere presence of a cat in the house, will be sufficient in such an individual to bring on an acute attack of asthma.

Horse asthma sufferers cannot go near a horse, much less ride one, and in some cases merely talking to another person for a few minutes who has been riding a horse and has not changed his clothes will be sufficient to bring on an attack of asthma. Needless to say such an individual will be made acutely ill if given an injection of horse serum for any reason.

Other persons are hypersensitive to cats. I know of a case where a small boy suffered terribly from attacks of asthma until his doctor eventually found that it was due to cats. All cats had to be banished from the house and all toys made with cats' skin removed from the nursery. After that there was complete freedom from attacks of asthma for two years, when he again had several attacks. The same doctor was sent for and immediately looked round for a cat, and at last one was discovered in the kitchen, which the parents knew nothing about. It was just one of those cats which wander into a house and finding things comfortable take up their residence.

After the cat was removed the attacks again stopped, but two years later the doctor was summoned hastily because the asthma had returned. On this occasion no cat could be found, nor any toy, or other article, made from cats' fur, in spite of an exhaustive search. The doctor, however, was very painstaking and again went through the house himself. At last he discovered in a corner of the child's bathroom a small basket and inside was a live kitten. It turned out that the child had been given the kitten and, knowing that his nurse would not allow him to have it and that his parents would not allow a cat in the house, he had smuggled it into the house in the basket and hidden it in the bathroom, where he used to steal away to feed it with milk.

Science is only beginning to understand these curious phenomena, but now we have a clue it only wants patience and intelligence to find the causes which lie behind these cases. There are many curious puzzles connected with them. As everyone knows it is now possible to transfuse blood from one human being to another. When a patient is very anaemic, or has lost a great deal of blood, it is a comparatively simple matter to transfuse fresh blood into him or her from another person and the results are immediate and miraculous. It is an amazing sight to see someone

who is lying in bed, deathly pale and almost unconscious, suddenly come to life again after a transfusion. In two or three minutes after the transfusion their proper colour returns, they are conscious, alert and talking. These cases are common now, but a hundred years ago would have been claimed as miracles.

Now when a patient is transfused it is necessary first to find out if the blood of the donor matches with the blood of the patient, because if the bloods do not match the transfusion may cause the death of the patient. Human bloods are divided into four groups, and it is absolutely necessary that an individual whose blood is, we will say, in Group 2 be transfused only from another individual of the same Group, or there may be disaster. This is well known to doctors and in large hospitals and similar institutions, where blood transfusions have to be frequently carried out, lists of willing donors of blood are kept and the group they belong to is recorded, so that a suitable donor can be quickly obtained for any patient who requires transfusion. When very serious operations have to be performed the blood-group of the patient is ascertained beforehand and the attendance of a suitable donor arranged for.

The exact cause of this curious phenomenon, which renders the blood of one individual poisonous to another, though they may be brother and sister, is not yet understood, but it is due to what we call allergy, and is caused by certain proteins present in one blood which do not fit with those in the other.

One would hardly imagine that blood or milk which has been carefully sterilized would act as a poison when injected into a human being, but such is the case and alarming, even fatal, symptoms may result from such an injection.

The injection under the skin of a syringe-full of sterilized milk may act as a fatal poison and will almost certainly cause quite alarming symptoms. It is not even safe to take some of the person's blood and then inject it into him again, as it may in some cases cause a violent reaction.

Injections of sterilized milk are to-day sometimes made use of to produce a condition known as protein shock. Such an injection will sometimes cause the patient's temperature to go up to 104 or 105 and a temporary acute illness. This procedure is occasionally of value in raising the patient's resistance to an infection which he appears to have no power of combatting.

Another very curious phenomenon has recently been discovered, which appears to act somewhat similarly. Drug addicts, that is people who have contracted the habit of taking heroin,

morphia, or cocaine in large doses, and are unable to give up the habit, are proverbially difficult to treat, and often prove to be quite incurable.

If the drug is withheld they become so ill that their life is in danger, and the drug has to be given. If it is found possible to deprive them entirely of obtaining access to it, they go to any lengths to obtain it as soon as they are freed from restraint. These unfortunate people become a misery to themselves as well as a nuisance to others.

It has been discovered that if several large blisters are made on the skin of such a drug addict by the application of blistering fluid, or in some other way, and as soon as the blisters have formed the fluid within the blisters is sucked out with a hypodermic syringe and injected under the skin of the patient, he loses all desire for the drug and suffers no ill effects from being deprived of it. The injections have to be repeated for some time, but a number of cures have been reported as the result of this curious treatment.

CHAPTER XVI

HORMONES

HORMONES are internal secretions. We all know what a secretion is. We know that milk is a secretion from the mammary glands, and everyone knows that when we see or taste food we get a flow of saliva which is a secretion from the salivary glands in our mouth which assists us to digest the food. Most people also know that there is a secretion of digestive juices in the stomach which liquefies meat and enables it to be broken up into material which can be absorbed into the system as food for the tissues. All these secretions are chemical substances manufactured by glands in the body. There are, however, other secretions which are poured into the blood stream and not on to the surface and are of the utmost importance in the economy of life.

Our knowledge of these so-called internal secretions, or hormones, is comparatively recent and there is still a great deal to be learnt about them. Already the exact chemical composition of many of them is known and several of them are being artificially manufactured in the chemical laboratory from coal tar and have been found to have the same action as the natural product.

The first hormone to be discovered was thyrotoxin, which is the chemical substance secreted by the gland situated in the front of the neck called the thyroid. Some children are born with deficient thyroid glands and when this happens the absence of a proper amount of thyrotoxin in their blood most seriously interferes with their development, with the result that they grow into what we call cretins. Before the discovery of the thyroid hormone there used to be large numbers of these cretins in some of the Swiss valleys, and in other parts of the world. If, however, daily doses of thyroid extract, prepared from the thyroid glands of animals, or from the artificial thyrotoxin made in the laboratory, are administered to such children they very soon change in a miraculous manner. Their bodies develop and become normal and instead of being semi-idiots their intelligence also becomes

normal, so that if fed daily with thyroid gland or the artificial substitute they soon become quite normal children in all respects. But they always have to be given daily doses of the drug in suitable quantities to supply the deficiency of their own thyroid glands, and if the supply is stopped they slowly but inevitably revert again to the condition of cretinism.

In a normal person the amount of thyrotoxin secreted by the throid gland is beautifully adjusted to the requirements, but in certain diseased states the gland over-secretes and too much thyrotoxin finds its way into the blood. When this happens there is a great deal of trouble. The heart beats much too fast, due to its being over-stimulated, and tends, so to speak, to run away like a motor-car engine when the throttle has stuck. The patient becomes excitable and nervous, the eyes tend to be pushed out, giving him a very ugly appearance, and the individual becomes very ill. In such cases it is found that the thyroid gland has become enlarged, or that there is a tumour in it. In these days such cases can be cured by surgery. The surgeon removes the tumour, or a large part of the enlarged gland; the patient gets quite well again, and the unpleasant symptoms disappear.

One of the most interesting of the hormones is adrenalin. This substance is secreted by a small gland on the upper end of the kidney and is responsible for a great many of the activities of the human body. When we get angry and "see red" as it is said, it is because some nervous emotion has caused a sudden extra secretion of adrenalin into our blood stream. We all know that when a person is suddenly frightened, or is attacked, it results either in their becoming combative or running away. They attack whatever it is that has startled them, or flee from the danger. It will depend largely on their mental make-up and upon the nature of the danger. If the danger is a fire or an accident, they will try to run away, while if it is a robber they will attack him or scream for help. But whatever the reaction is, the person always displays quite an unusual amount of energy. A bedridden woman has been known when frightened by a fire to run downstairs, although the day before she was quite incapable of getting out of bed, and quite physically weak men and women have been known to put up an extraordinary fight when assaulted with violence, displaying much more energy and courage than could have been expected. This is all due to adrenalin, which has flooded their blood as a result of the emotional stimulus. Of course, some people have the ability to secrete much more adrenalin than others under

such circumstances, and these people are usually called courageous. When we are thrilled by seeing a man, a horse, or a greyhound win a race by putting on a tremendous spurt of speed just at the critical second, it is due to the fact that he has suddenly flooded his blood with adrenalin.

Adrenalin is most potent stuff. The artificial product is used sometimes to bring back to life people who have been drowned, or died from an electric shock or an overdose of a drug. If a little of it is injected straight into the heart muscle, it will make the heart begin to beat again even though it had been stopped for some minutes.

One of the most curious effects of adrenalin, however, is seen when a tumour forms in the adrenal gland. This occurs very occasionally in children and when it happens the result is that too much adrenalin gets into the blood. This has the effect of over-stimulating all the other internal glands, but particularly the sex glands which as a result develop at an unreasonable rate.

I remember not long ago seeing a small boy of four years of age with this condition. His size was normal for his age, but he was fully developed in every other way. He was in fact a small man. He was growing a beard, his muscles were well developed and he had a deep bass voice. He was in a children's hospital and it was necessary to get a porter to dress him and give him his bath as the nurses were shy of doing so. These cases of precocious development are well known to doctors and the cause is known to be a tumour in the adrenal gland. In a few cases the child has been operated upon and the gland removed with the rather surprising result that the child has lost all his precocious characters and returned to the condition of a normal little boy of four, or whatever his age was. The voice has changed back to the ordinary squeaky one of a small child and all the hair except that on the head has disappeared. The opposite result is also occasionally seen where a child of say five years old has suddenly ceased to develop at all. The result has been that, though the child is quite normal, as the years pass no progress is made at all and when it is fifteen in actual age in every other respect it is still five. I knew of a case of this kind where the patient looked and behaved as an ordinary baby of five years, but her real age was thirty-six.

There is another hormone called pituitrin, which is secreted by a small gland in the brain. This secretion has very important properties, but they are not very well understood at present and when anything happens to the gland doctors can do very little to

correct matters. There is a curious disease caused by a tumour growing in the gland. The condition is not fatal, but it results in the most monstrous overgrowth of certain parts of the body.

All this is due to the disturbance of a small gland not larger than a hazel nut in the brain and shows what extremely potent substances hormones are and what profound effects a little too much, or a little too little, of their secretion can have upon the human body.

Quite recently another hormone has been discovered called oestrin. It is the presence of this substance in the blood which makes female animals come "on heat" and which makes their breasts enlarge and secrete milk. It has all sorts of strange effects and when administered in large doses produces abortion.

There are very many hormones, a few of which are known, but a great many which still remain to be discovered. They are part of the machinery which enables the bodies of humans and animals to function properly, and good health is that condition in which a perfect balance exists between all the different organs, so that all the hormones in the body are present in just the right amounts at any particular time. How this beautiful balance is controlled is one of the great puzzles of life. The slightest variation from the correct balance in either direction will result in some form of illness or disease, and the individual will no longer be normal in some sense or another. Each and every hormone is dependent on all the others; one stimulates another to more or less activity as required to meet any one of the emergencies or vicissitudes of life, and we can only stand and wonder at the amazing accuracy with which the system works. If the balance is upset at any time it always tends to swing back again to the normal.

Medical science is now beginning to understand something about hormones and how they work. Many of them have been isolated and are now available as drugs, but the proper method of using and administering these powerful chemical substances is as yet but little understood. Many of the artificial hormones refuse to work as we should expect, or give unexpected results, but slowly and surely our knowledge is increasing and one abnormal state and kind of illness after another is being brought under adequate control. Even old age will in all probability be to a large extent prevented by the administration of suitable artificial hormones in the near future. Whether this will be to the benefit of the human race or not remains to be seen but it is quite possible

that in the near future hormones will be discovered which will enormously prolong human life and vigour. One hormone has been discovered which appears to have the property of arresting a certain form of cancer when administered continuously in suitable doses.

There would seem to be great possibilities in this form of treatment.

CHAPTER XVII

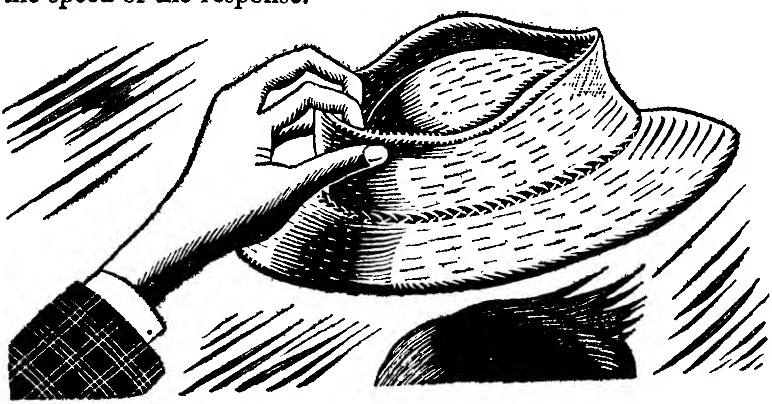
REFLEXES

As everyone knows the human brain is a kind of telephone exchange served by a most elaborate information service which we call the sensory nerves, and working by a relay system through which motor impulses are sent out to various muscles and result in some movement appropriate to the occasion.

If, when we are walking, we see that a stone, or other object, is going to trip us up, a message passes from the retina of the eye to the brain, and another message is at once sent out to the muscle to arrest our forward movement, or to deflect our legs to one side of the object.

We hear a sudden sound and at once in response to the message which has reached the brain the head and eyes are turned towards the direction of the sound. Every conscious movement that we make is in response to some message picked up by the sensory nerves. Such sensory messages have to be relayed, so to speak, through several different centres in the brain before the required motor impulse can be sent out to the muscles which will carry out the necessary movement. This all takes place with amazing speed, but there is nevertheless a certain fraction of time necessary for all this to occur.

It is here that the acquired reflexes come in and for certain necessary actions provide a short cut which greatly increases the speed of the response.



To illustrate this we may take the case of a man wearing a hat on a windy day. A sudden puff of wind comes and threatens to blow off his hat, but in the fraction of a second his hand comes up and catches his hat before it has lifted more than halfway from his head. If you consider that he will not be conscious of the fact that his hat is in danger until it has started lifting from his scalp, and that before it has had time to move farther his hand, in response to an action of his brain, has come up in time to prevent it being dislodged, you can obtain some idea of the amazing rapidity with which the appropriate response to the sudden and unexpected movement of his hat has taken place. This is due to an acquired reflex having been established for this particular purpose, namely to save his hat from blowing off in a sudden gust of wind. When he was a child his hat invariably blew off and had to be rescued by his nurse or some passer by, but with practice he has established what we call a reflex, in other words, a short cut. Instead of the sensory impulse having to pass through the thinking part of the brain it is automatically switched at once to the motor centre that will make his hand move to his head. The act of saving his hat instead of being a conscious one has become unconscious and automatic.

With training we accumulate a great number of such reflex or automatic actions. Everyone has seen a child fall down when running and will probably have noticed that the child bumps his nose or face upon the ground with painful results, though not as painful as they would be were he or she an adult. But a grown person who trips when running never strikes his face on the ground because he has acquired an automatic reflex which makes his hands come forward and prevents his face from coming in contact with the ground. The adult may injure his hand or wrist but he will never bang his nose on the ground. These are very simple examples of acquired reflexes, but there are very many others which are not at all simple.

Riding a bicycle is only possible by the development of an acquired reflex; the act of balancing oneself on a cycle comes from a reflex being developed for that particular purpose, and as soon as it has been acquired the balancing of oneself on a cycle is entirely unconscious and requires no thinking at all. Many sports such as golf, cricket and tennis depend upon the development of such reflexes by constant practice. The marvellous feats of balance performed by equilibrists and jugglers are achieved by the same means.

Many of the lower organisms, such as star fish and hermit crabs, appear to react entirely to inherited reflexes. Thus if a hermit crab, living inside a shell which does not belong to him but has been left out by some deceased snail, finds an empty shell, he will transfer his soft body from the shell which he is at the moment inhabiting to the new shell, quite irrespective of the fact that this new shell is not nearly as suitable for his purpose as the one he had. The mere sight of a new shell, however, excites his reflex to change and change he does. If a number of these hermit crabs are placed in an aquarium with several empty shells they will constantly change shells.

The shadow reflex of many small organisms is an interesting example of an hereditary reflex. As soon as a shadow falls upon the organism it withdraws itself into its shell, or ceases to move. The object of the reflex is to hide from danger by withdrawing into its shell, if it has one, and so protect itself from an enemy who might eat it. The shadow may be caused by such an enemy, or it may not. It is a clumsy expedient since the organism may have to withdraw very many times when there is no danger at all, but such organisms have very primitive sensory organs and this shadow reflex is their only protection. In the case of those animals which have no shelter such as a shell in which they can hide, the reflex causes them to remain stationary and stop all movement. We all know that it is something moving which catches the eye and that an animal which remains quite still will often go undetected.

Another curious example of a reflex is exhibited by a sand animal *Mya Arenaria* which lives under the sand and makes a vertical shaft upwards to the water through which it pushes a tubular syphon to obtain food and oxygen from the water. If this syphon tube were pushed up above the sand and projected into the water, the first fish that came along would bite it off, but there is a light reflex which protects it. If light falls on the syphon tube it automatically retracts under the sand, so that by the operation of the reflex the tube is always kept just below the upper

sand level where it will be safe from any prowling fish.

Many of the reflex actions to shadow and light have been studied in sea organisms, but the exact significance of such actions is sometimes not obvious.

If a light is placed on a table in a dark room and a small beetle or caterpillar is placed about a foot away, the insect will go past the light; if now the light is moved to the opposite side the insect will turn through 180 degrees and go in the opposite direction to that in which it started. Many insects will continue to revolve round and round the light. Everyone has seen insects flying round a lamp until often they collide with the glass or destroy themselves in the flame. Their action is entirely reflex, but what object it has is not so evident.

Some of the inherited reflexes are very interesting. I once had the opportunity of experimenting with one such reflex. The occasion was in India where outside Bombay there is a special station Perelli for preparing anti-snake venom. There are a number of different snakes kept at the station for the purpose of collecting the various venoms. There were several live cobras and Russell vipers, and all these snakes were inside boxes with stout glass sides. The Russell viper is about four or five feet long and one of its peculiarities is to emit a most unpleasant hissing noise when disturbed. I was told to try and hold my hand on the glass side of the box and allow the viper to strike at it. I thought this would be quite easy, but I found after trying for some considerable time that it was utterly impossible. The snake, when it saw my hand, reared up its head, emitted an unpleasant, angry hiss and then struck straight at the hand. I found long before the snake actually struck I had withdrawn my hand from the glass. By no power of will could I keep my hand in contact with the glass, although, of course, I knew the snake could do me no harm. I was told that this experiment had often been tried, but always with the same result. In other words, although for thousands of years my ancestors cannot have been in any danger from snakes, I had inherited from past ages a reflex which impelled me to remove my hand when I saw the snake about to strike, and I was quite unable to overcome the reflex action which, although for generations it had not been used, is still there in my brain cells to come into action when the visual stimulus is brought into play.

CHAPTER XVIII

WHAT IS OLD AGE?

THE human machine, like a motor car or any other kind of machine, is bound in time to wear out, but the human body, unlike man-made machines, has a self repairing mechanism which is extraordinarily effective. Worn parts can be replaced; old ones, within certain limits, renewed permanently; damaged parts compensated for. It is self lubricating, self adjusting; worn parts are automatically removed and the whole framework is in a continual state of renewal; with the exception of a few parts, such as the teeth, brain and muscles, almost the whole body is refitted anew every few years.

Yet sooner or later the human body begins to show obvious signs of wear and eventually breaks down, and the engine stops for ever. It is interesting to speculate why this happens and what are the chief factors leading up to the ultimate breakdown of the machinery and see how we can alter or postpone the time when the machine becomes unable to carry on its job.

Very few people, if any, desire to live to an advanced age if this must mean that they are bedridden or a nuisance, have to be fed with a spoon or are what is described as "gugar."

Now one of the curious things about old age is that the human mind, the thinking part of the brain, seems to age very little, or very slowly, so that provided the rest of the body is functioning reasonably well and the heart is

able to pump good red blood through it in proper quantities, the brain will remain as active and as useful as ever it was. Indeed in some ways better, because the brain of an elderly person, if it has been properly used, is a storehouse of knowledge and experience.

Of course, an active brain is not of very much use if the senses which feed it, such as the eyes and ears, are not functioning properly, but assuming that the individual can hear reasonably well, either with or without artificial aid, and can see to read easily with suitable glasses, the brain will continue to work as well as ever in most people provided their other organs and their blood vessels are functioning reasonably.

Modern medical science is said to have added over ten years to the length of life of the average man and woman of the present day. Well-fitting artificial teeth have enabled an elderly person to bite up his food as well as ever he did and, with the aid possibly of artificial digestive juices, keep his digestion up to the mark; whereas a few hundred years ago he would have had to be fed on pap after his teeth had all decayed or fallen out.

The human brain is made of nerve cells which, it is believed, are never replaced once the brain has reached an adult stage.

Once the cells have been laid down they remain for the remainder of life, though most other tissues of the body have to be replaced by new cells from time to time. This seems to explain why it is that the human brain retains its functions unimpaired long after the other organs have shown signs of failing, for the cells are the same as they have always been during life, and if they get adequate nourishment from the blood should continue to do their job as well at eighty or ninety as at thirty years of age. We all know that there are very many old men and women whose mental faculties are as good as ever though they are not very strong physically, or able to move about much.

It is a curious fact that the first signs of deterioration in the body mechanism occurs in the muscles and that occurs quite early in life. We say that a man is in his prime at forty years of age, but as a matter of fact this is not true of everything. For instance we know that a man of forty is too old to play football well, however good he may have been when he was younger.

If he has been a good oar and has won his rowing blue for one of the Universities, he will certainly not be able to row his best at forty and will be very foolish if he tries to row at all.

Should he be a boxer he will be on the shelf long before

he reaches the age of forty. Few boxers do much good after thirty years of age. If he is an athlete he will certainly have had to give up running by the time he reaches the age of forty.

While I think no one will dispute these facts they are certainly rather puzzling. If instead of considering pursuits which require very powerful muscles and very rapid action, we take something which requires great endurance over long periods, then the men between forty and fifty can often outstay the younger men, as was well demonstrated in Scott's last South Polar Expedition, where the ultimate survivors were the oldest members of the expedition.

It is evident that where very strenuous exertion is required over a short period of time youth is essential, and in the ability to undergo the extremes of exertion and take much punishment in the way of hard knocks etc., the absolute limit is passed soon after thirty.

There is another curious fact. If a man of thirty or under overstrains himself, nothing serious happens as a rule beyond his temporary collapse, and if he does injure himself the damage will be a broken bone or a strained joint, but if the same thing happens to a man of forty or over he will permanently damage his heart, or he will tear one of his muscles.

As we get older certain changes almost inevitably occur. At about forty-five the eyes begin to change so that glasses become necessary for reading, even though before that the eyes were quite normal. The other organs are also affected in the same way, so that fatigue comes on more easily and recovery from it is slower. Of course, there are enormous differences in different individuals, the cause being almost certainly hereditary. The members of some families live habitually to a much greater age than others; this has been proved statistically from the histories of a great number of carefully investigated families.

The heart is probably one of the organs which is the slowest to show signs of wear provided it has never been seriously damaged. It is often stated that rowing athletes always die young owing to the very strenuous exercise having damaged their hearts, but some of my personal friends when I was at Cambridge were rowing men and they are now all over sixty and are exceptionally young and vigorous men for their age, so that I do not think this idea is correct, always assuming that a rowing man starts with a sound heart to begin with and does not abuse it by continuing to row after he has reached the age of thirty. Quite recently a

series of statistics was published which proved that Rowing Blues tended to live longer and to maintain good health and sound hearts rather longer than the average of the population.

Most of the disabilities of old age arise from the fact that the internal secretory glands, which secrete the hormones (see Chapter XVI) begin to lose their activity and the hormones, upon which so many of the activities of the body depend, are not secreted in sufficient quantity to maintain the normal vigour.

Another important factor is that as age advances the elimination of waste products from the blood and tissues occurs more slowly and less completely. There is thus a tendency for these waste products to accumulate and cause damage. As an instance of this one might quote the results of over exertion. If a youth over exerts himself by excessive exercise of any kind he will get very sleepy, will sleep deeply and long and probably wake up quite fit again, but an elderly man will probably be kept awake all night from the poisons (toxins) generated as waste products in his muscles and next day he will feel tired and listless, his muscles will be what we call stiff and painful and it will be several days before he has completely recovered from the effects of having over exerted himself.

It is at least extremely probable that medical science will soon have discovered how to make good this deficiency by the administrations of artificial hormones, and when this happens many of the disabilities of old age will be removed and we shall be able to live far longer and in greater comfort and vigour than our fathers and mothers.

Some very remarkable experiments were carried out recently upon rats. An old rat, whose coat was mangy and thin, whose tail trailed behind him and who seemed to take little interest in life beyond eating and sleeping, was operated upon and some gland tissue from a baby rat was grafted into him. After he had recovered from the operation a remarkable change occurred. He became more lively, he carried his tail erect, his eyes became bright and alert, his coat got thicker and became smooth and glossy once more, he showed a marked interest in the female rats, and he exhibited all the characters of a vigorous rat in the prime of life. He had got new glands and new hormones instead of his old ones and it changed everything.

What can be done in rats will one day be able to be done in humans, and who can foretell the consequences.

No doubt the same would be true of human beings and if the

glands of a male baby were grafted into an old man the latter would, at any rate for a time, be rejuvenated.

There is little possibility of this happening as the glands of male babies cannot be obtained, at any rate in any civilised country, and any attempt to obtain them would, quite properly, cause a universal outcry.

It was hoped that the hormone substance which is secreted into the blood by the Gonads, that is the sex glands, could be extracted from the glands of slaughtered animals and used to produce the same results as the actual grafting of the glands themselves. Such extracts have been made and many of them are now obtainable, but they do not produce the desired results, or at any rate the results are very much less spectacular than is the case with grafts.

Grafts of animal tissues—even the monkey glands about which much has been written—are a failure because if we introduce tissues from one species of animal into another they are immediately destroyed by the tissues of the host.

One day, no doubt, the actual chemical substance which is responsible for the effects produced by the sex hormones will be discovered and made available in a form in which it can be injected or digested. This has already been achieved in the case of the female hormone, Oestrin.

When this happens, it will be possible to restore to old people a considerable degree of the activity of their youth by the administration of tabloids or hypodermic injections.

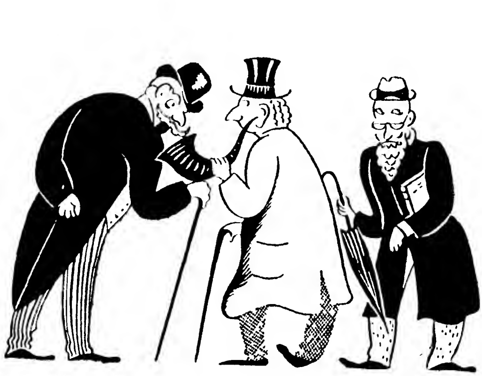
Accidents and disease apart, there is every probability that future generations will live longer than the present generation, and enjoy the full exhibition of their faculties. It may well be a bad thing for the world, since any prolongation of life means a very serious increase in the total population and less chance of employment for the young, but perhaps by then we shall have discovered how to adjust our population to our environment instead of, as now, leaving everything to chance.

Finally a word to the wise. As you get older, as inevitably you must, do not let it worry you. After all you would not like to remain always young while all your contemporaries got old around you. So make the best of it. Realize that you cannot do quite so much in a day as you used to do, you want more rest and less strenuous hours. You must not try to go so fast or quite so far as you have been accustomed to do. You should play one round of golf where you used to play two. Take longer holidays and more frequent

ones. Do not stay up late at night and above all do not eat so much as you have been accustomed to. You do not require the food and your body cannot so easily deal with an excess of it. Far more people damage themselves by eating too much than by drinking too much.

In other words go a little slower. After all, if you have made anything of a success of life you should be able to limit the speed a little without seriously interfering with your normal activities, and a little less "nose to the grindstone" does give a chance to the next generation to apply their own noses, which if they are any good they will be only too pleased to do.

Change your more active pursuits for more sedentary ones, the activities of the brain can afford quite as much pleasure as those of the body and are much more suitable and worth while for older people. Life can be a very pleasant thing, but much depends upon the ability of the individual to adapt himself to it suitably.



CHAPTER XIX

THE GOOD OLD DAYS

HOW often does one hear this phrase. The suggestion, of course, is that in previous centuries life was pleasanter, more comfortable, and happier than it is now, and that we are to be commiserated with because we have been born in this instead of some previous century.

We live now in an age of bustle and hurry, of wars and rumours of wars, of insecurity of life and fortune, and it is perhaps natural that in our minds we should envy those ancestors of ours who lived in the time of Queen Elizabeth, of Charles the Second, or Queen Anne, when wars were only small affairs that did not personally concern the average citizen either directly or indirectly, and life went slowly and peacefully by. When there were no trains, motor cars, steamships or telephones; when bombs could not come down from the sky upon our streets and houses, and a war on the other side of the Channel was little more than a topic of conversation.

I have often wondered how many of those who talk of the good old days have stopped to consider what the expression really implies. Was the past better than the present as regards the things to which we attach the most importance?

We can only judge things as we know them, and must inevitably consider the past in contrast to the present. We have only been brought up in the present and were we by some miracle to be transported back into the past we should of necessity judge the past by comparing it with our own experience of the present day. As our mentality and reaction to our surroundings would be different from those persons born in the age in question, it would be quite impossible to draw any satisfactory comparison.

History, as we were taught it at school, was chiefly an account of kings and queens, the dates during which they reigned and the principal events that occurred during their tenure of the throne. I have always thought that kings and queens of history are extraordinarily uninteresting. After all, who cares who they married or how many children they had?

What is interesting in history is the condition of the common people, how they lived and how they behaved. Until recently

our history books told us nothing about the way in which the people of a nation or country lived and behaved; in reality the only really interesting part of history.

The time of Louis the Fourteenth, the "Grand Monarque," was certainly one of the most magnificent periods of history in Europe. At no time either before or since has there been such luxury or pomp as existed at the Court of Versailles. A wonderful palace, a magnificent Court, lovely ladies, brilliant men, great soldiers, wit, intelligence, vice, humour; nothing quite like it has been seen since that time in any Court of Europe, or is ever likely to be seen again. Yet a letter written by Queen Henrietta of England, the wife of Charles the First, to her daughter Minett, who was on her way to Paris in order to be married to the brother of Louis the Fourteenth, gives a curious sidelight upon the living conditions of those times. The Queen gave her daughter instructions in the letter as to how she should behave as a Royal Princess. She told her daughter that when she got up in the morning she should first of all comb her hair, but that this should not be done till after she had got out of bed, so that the lice should not fall in the bed, and that when throwing her night slops out of the window, she should always look out of the window first and make sure that they did not fall on any passer-by.

There is a description in the contemporary account of the time of *Le Roi soleil* of the Levee of His Majesty one morning when he was feeling indisposed. The Court physicians were sent for and prescribed a clyster (enema) for His Majesty. The appropriate attendants were sent for and then the Master of the Ceremonies opened the doors leading into the great salon, where all the Court were waiting, and announced that, as His Majesty was about to have an enema, the number of those who could be admitted to the bedchamber would have to be limited and that only twenty of the Court ladies could be admitted.

The ladies of the Court at that time were accustomed to wear sachets of perfumed herbs in their arm-pits so as to disguise the smell of their unwashed bodies. It may seem remarkable that even the Court ladies could not keep themselves clean in those days, but it must be realised that water for washing or bathing was not available. Though there was a special water supply to work the fountains in the gardens of Versailles, there does not appear to have been any water available for washing or having baths, and indeed most of the Court would have been horrified at the dangerous practice of having a bath.

In London, at that time, no water was laid on to even the most luxurious houses. If people wanted water in those days they had to buy it from the itinerant water carriers who were known as "Cobs" and who went round from house to house in the city selling

water by the quart. Some of the water came from the conduits and was brought in pipes from Tyburn, Hampstead and other places near London. It could be fetched by the household servants, or bought from the water carriers, but it was necessarily very limited in amount, and as the greater part had to be used for cooking and drinking the quantity available for washing was extremely limited.

The cost of water, except to those who happened to live close to the river, or the conduit, was such that washing the person was impossible for the poor, and a very occasional and most expensive luxury to the rich.

The Thames was little better than a sewer in those days, as all excrement and rubbish of the town was emptied into it, and the water from the conduits brought into London by pipes was little better, if we can believe the accounts of the time.

The poor of those days were much poorer in comparison than the poor of to-day, and even the rich had few of the luxuries that we should now call necessities.

The best that even princesses could do in the way of ablution was to clean their faces and hands with a damp cloth. By modern standards the average nobleman and noblewoman would have been considered filthy, and personal cleanliness simply did not exist.

There were at that time no public lavatories or conveniences of any kind. The streets were ankle deep in filth of every description. Heaps of refuse accumulated before even the houses of the nobility; blood and guts from the butchers' shops lay about in the streets, and there was no one to clean up the mess. Most of the City of London had no sewers and everything was thrown out into the street to be washed away by the next rain to the lower levels, where it accumulated. Pepys recorded in his diary that his neighbour's cesspool had flooded his basement and made his house uninhabitable.

Washing in the old days was a luxury which could only be indulged in a few times during the year when a good supply of water was available, and a complete bath in warm water was something quite exceptional even as recently as eighty years ago. Even in late Victorian times few persons expected to take a bath oftener than once a week; that was the height of refinement. To-day, we most of us expect, and generally find, hot and cold running water wherever we go, and if the water is not clean and wholesome we should complain to the local authority.

Cleanliness only became possible with the advent of an unlimited clean water supply, and without it we should have to put up, as our great grandfathers did, with lice and fleas in our beds and in our hair and clothes.

In 1580 or thereabouts, one Peter Morrys, a Dutchman, fixed a water wheel in the first arch on the northern end of Old London Bridge to pump out the water of the Thames for the benefit of the citizens. He was given a lease for 500 years at ten shillings a year, and he renewed the lease two years later. This lease of his does not expire till the year 2082 and in the meantime, the Metropolitan Water Board, who have bought up all the old leases and monopolies for supplying water to the City of London, have to continue to pay rental to the successors of Peter Morrys.

A few years ago a friend of mine bought an old estate on the southern border of London and converted the ancient manor house into a hotel with all modern conveniences, such as bathrooms to all bedrooms and modern plumbing. He had bought the estate complete with everything it contained, and among the effects there was a large chest of very ancient documents, which he sent to his solicitors to be looked at. When, at considerable expense, he had rebuilt and converted the ancient manor, he found that the water rate would be in the neighbourhood of £800 per annum.

One day, however, his solicitor informed him that among the ancient documents in the old chest there was one in which the New River Company guaranteed to supply the Lord of the Manor which he had purchased with all the water he might require *for ever* for the sum of one pound sterling per annum. This deed was very old, but when counsel was consulted proved to be quite sound, and as the Metropolitan Water Board had bought out all rights of the New River Company, including all their liabilities, they are now obliged to supply his hotel with all the water it requires at the ridiculous sum of one pound per annum.

It was not until 1613 that the New River Company brought a good supply of water to the cistern constructed at Clerkenwell and this water was distributed to various parts of London by means of wooden pipes.

These old wooden and stone pipes are still often dug up when foundations for houses or new roads are being constructed. The wooden conduits are just large logs through which a hole has been bored. It was much later before water was piped into private houses and became obtainable in practically unlimited quantities.

It is interesting to note that as the citizens of London gradually got accustomed to the necessity of a private water supply of their own the New River Company's shares rose considerably in value. The original shares were seventy-two in number and represented a capital of £250 each. In 1737 one share was worth £5,250 and in 1889 a single share was sold for £112,800.

Soap was first brought to England in the thirteenth century, but it was not till the fourteenth century that it began to be manufactured on a commercial basis, and became available to the ordinary householder. There was at first a heavy tax on soap, the tax being more than the value of the soap itself. It was not until the tax was removed in 1852 that it became both cheap and plentiful.

The great head-dresses which fashionable ladies wore in Stuart times must have been harbingers of fleas and lice, and as these elaborate structures could only have been taken down and redone very occasionally one may imagine the condition of their interior. The full bottom wigs of the Regency period must also have been breeding places for lice and fleas, but in those times people were so accustomed to a few more or less harmless parasites on their person that they paid little attention to them.

Cleanliness, both of the person and of the surroundings, is quite a modern achievement and has only been really made possible within the last century. Early man no doubt gave himself an occasional bath in some stream or pool and by vigorous rubbing probably succeeded in removing most of the dirt from his skin and hair, but as he had no soap to assist his ablutions he was probably not very successful in obtaining what we should consider cleanliness and almost certainly failed to rid himself of his parasites, such as lice and fleas.

Washing in water was in all probability seldom indulged in and the common practice seems to have been to smear the skin all over with fat and oil. This no doubt cleaned off a great deal of the dirt and, by making the skin shine, much improved the appearance. This is still a common practice among natives and in many parts of Asia, and where water is scarce is probably the best method. Rubbing of the skin with fat not only removes some of the dirt and improves the appearance, but also most seriously incommodes the fleas and lice, so that it serves a double purpose.

In those "good old times" artificial teeth had not been invented and after middle age most men and women either had a mouth full of decayed teeth, or had hardly any teeth at all and were obliged to feed themselves on pap. From the lack of teeth the cheeks fell in and the average person of fifty looked probably a great deal older than the average citizen of seventy of the present time.

When artificial teeth first came into fashion they were laboriously carved out of a block of ivory. They were expensive and they fitted so badly that they were liable to fall out on the least provocation; not only that, but they decayed as readily as the original teeth which they had replaced.

There were only very primitive dental forceps and teeth that had to be removed were either prised out with a sort of chisel, or wrenched out with an instrument called a key; of course, without any anaesthetic.

A broken leg in the old days almost invariably meant being lame for life, and an attack of appendicitis meant probable death for the unfortunate sufferer and a trial for poisoning for the members of his family. There is little doubt that many of the famous poisoning cases of the middle ages were not due to arsenic or any other mysterious poison, but cases of acute appendicitis or intestinal obstruction, and many an unfortunate person has been broken on the wheel, or drawn and quartered because his employer had died from acute peritonitis, which the physicians of those days were unable to diagnose.

Anyone who was obliged to undergo an operation had to be forcibly held down by strong porters, while the surgeon did the necessary cutting; there were no anaesthetics and the patients had to bear the pain as best they could. If they did not die from the pain and shock, their chances of surviving the operation were only about one in three, as most of the surgical patients of that time died from sepsis or gangrene.

Modern transport and the means of preserving food now enable us to obtain, provided we can pay for it, fresh meat, vegetables and fruit during the whole of the year. Our children can have fresh milk during both summer and winter, and as a result their growth and development is not at any period of their youth restricted. But until quite modern times, fresh milk, or even good healthy preserved milk, was not available during the winter months, because there was no means of feeding the cows so that they could be kept in milk, and the children had to live on pap—a very poor substitute for fresh cows' milk.

Even in the best county families meat was seldom eaten more than once a week, generally on Sunday, and the poor never tasted meat at all, unless they poached a rabbit or a pheasant at the risk of being transported to the colonies as a slave. Fresh vegetables could only be obtained in their due season, and then only from the garden or the farm. Fruit was only available when it ripened in the orchards; whereas to-day there is no time of the year when fruit from any part of the world cannot be bought comparatively cheaply in any of our large cities.

We talk a lot to-day about Vitamins and their importance in our diet, but from where did our grandfathers obtain them? Their food was poor in Vitamins; they had little fresh fruit and almost all their vegetables were cooked, but somehow quite a lot of them managed to survive.

No, the truth of it is that we have a lot to be thankful for and little to regret that we live in these times and not in what in moments of exaggeration we are inclined to call "the good old days."

CHAPTER XX

THE BEGINNING OF THE HEALING ART

How the healing art began or what its earliest manifestations were we do not know and can only conjecture, but that it arose at a very early stage in man's history we can be certain.

The desire to be healed of wounds, or cured of a disease, must have been one of man's earliest desires, and other members of the tribe or family must have done what they could to try and revive those of their number who had been injured by accidents or in fights.

The earliest form of medicine was associated, we may be sure, with superstition and magic. The supernatural must have played a large part in the lives of all the primitive races of mankind, since they were unable to explain the natural phenomena around them, such as the rising and setting of the sun, which were such important factors in their lives.

Healing was at the beginning a form of magic, and the priests, or magicians, who pretended to interpret the will of the Gods were also naturally the chief exponents of medicine. Among the natives of Central Africa even to-day the word for priest, literally translated, is "medicine man."

The earliest attempts to cure the injured and diseased must have been very unsuccessful and those who practised it were only too willing, indeed were obliged, to shelter themselves behind the Gods of their time, in order to avoid reprisals by their victim or his friends. Their failures could thus be put down, not to their own clumsy efforts, but to the wrath of the Gods in question; an excuse for medical ineptitude which indeed survived up to very modern times. The only safe way for the medical practitioner of those times was to state that the recovery or otherwise of the patient depended upon the will and disposition of the Gods; a method which, while it necessitated the human practitioner having to give the largest share of praise or reward to the Gods for any of his successes, enabled him to foist upon the Gods the chief onus of his failures.

The oldest evidence we have of anything in the nature of a deliberate operation on a human being is in the Neolithic age. Skulls have been found with circular holes, which could not have been caused accidentally, and must have been made during the lifetime of the individual who originally owned the skull, since in many instances the edges of the opening shew undoubted evidence of healing. Very many of these skulls have been found and in a few instances the operation was only partially completed, owing no doubt to the sudden death of the patient and in such cases the method by which the operation was performed has been revealed. Not only that, but the actual flint implements with which the operation was performed have been discovered in some ancient burials. The bone was slowly scraped through in a circle until the round piece of bone in the centre was entirely loose and could be lifted out. A modern doctor who practised with the original flint instruments on fresh skulls found with experience he could remove the bone in about twenty minutes, leaving a hole in the skull about one inch in diameter.

These operations were certainly performed some ten to twelve thousand years ago, long before the dawn of recorded history. The fact that such a delicate, difficult and dangerous operation as trepanning was performed in early Neolithic times makes it seem certain that many other more obvious and less dangerous operations must also have been performed at that time with flint instruments.

It is hardly likely that trepanning was the only operation performed, but such other operations as were performed have, of course, left no evidence that we can find. For what condition these early trepanning operations were carried out we do not know. They were probably done upon an unconscious patient with the object of bringing him back to life and consciousness. There were, of course, no anaesthetics and the operation would be much easier to carry out on an individual who felt nothing during the process, and would, therefore, keep still.

If this was the case it argues a very considerable degree of knowledge of cranial surgery as we know that many cases of severe head injury can be saved from dying by trepanning.

How early man made the discovery that making a hole in the skull is a means of saving the life of someone who has been hit on the head with a stone hatchet and rendered unconscious is a puzzle. There is certainly evidence in some of the skulls that have been found that the individual lived for many years after the operation. This can be known by the appearance of the edges of

the hole in the bone, as the edges in such cases had become hard and dense, a condition which could only have been produced if the individual had lived for a long time after the hole had been made.

Another possible explanation is that the operation was performed on lunatics with the object of letting the evil spirit which was supposed to possess them, to escape. If this was so the operation must have been performed on a struggling patient, who was being forcibly held down or who had possibly been made unconscious by previously banging him on the head with a stone. The fact that such an operation would seldom, if ever, result in a cure makes it seem an improbable explanation, as it would not have been performed very frequently, which to judge from the number of such skulls that have been found it apparently was.

It seems more likely that the operation was performed for head injuries, which must have been quite common in days when a club or a stone axe were the chief weapons of offence and defence. If this is the correct explanation it argues a very considerable knowledge of surgery among the practitioners of the Stone Age.

In the times of the great civilisations of Babylon and Egypt, some 5,000 years ago, practically all knowledge, and certainly all medical knowledge, was confined to the priests and was handed down by tradition among the priesthood in the temples.

The amount of medical and surgical knowledge so far discovered in the cuneiform writings and in papyri of those times is quite inconsiderable, but as such knowledge would probably be kept in the archives of the temple and not buried with the dead, it would not have been preserved, or at least would not have the same chances of preservation as inscriptions in tombs and papyri wrapped up in mummies.

But there is evidence in the laws and customs of those times which indicates that the priests had a very surprising knowledge of the causes of many diseases. How they acquired this knowledge is, and will always remain, a mystery. But - See 1169 [illegible]

It must have arisen from very close observation of cause and effect over many years and logical deductions made from these observations by men with very astute brains. The chances of observing great outbreaks of disease, such as plague, were, of course, much greater than now.

Apart from foreign conquest the most serious catastrophes of those days were the outbreaks of bubonic plague. An outbreak

of plague would decimate almost entire populations, both by its direct and indirect effects. Half the population of a populous country or city would be dead in a few months. In the time of the Babylonians, and in ancient Egypt, when an outbreak of plague occurred the people sought the temples and invoked the aid of the Gods or Goddesses, and after suitable formalities and presents had been offered the priests interpreted to the people the answer of the Gods and laid down the law that must be obeyed to stem the pestilence.

The answer was that a snake should be turned loose in every house, treated with reverence and on no account injured or interfered with. In some temples the snake pits have been found where the snakes were no doubt kept for such an emergency. As the result of this procedure the plague would soon begin to abate and die out. The method was so successful that the sign or emblem of healing became a snake wrapped round a stick, and this emblem has survived to the present day and is still the crest or sign of medicine. It is to-day the crest of the Royal College of Surgeons of England.

Now the effect of letting loose a lot of snakes in the houses of those times would be that the snakes, crawling into all the holes and crannies, would eat up all the mice and rats, which must have infested the houses as they still do in insanitary dwellings to-day.

We know now that bubonic plague is due to an organism which is conveyed from one individual to another by lice, and that the rats and mice act as the carriers of the lice. We also know that we can prevent or stop the plague by the wholesale destruction of these vermin. The priests of ancient Babylon must have known that too, although *we* only discovered it the other day. At the present time very rigid laws exist in most sea-ports to prevent rats and mice from coming ashore from the ships and bringing plague from distant ports, and a constant war against these

rodents is continually going on in most civilised countries. The ancient priests of Babylon probably did not know about the lice, but at least they knew, probably from careful observation, that vermin were the carriers of plague and that extinction of the vermin was the correct way to stop the plague. This is all the more remarkable when one considers the indirect connection between rats and infection.

The Egyptians had the same knowledge and a snake's head was part of the royal diadem of the Pharaohs. Indeed the Egyptians went further, as they made the cat sacred and untouchable so as to ensure the maximum number of cats, and thereby the minimum population of rats and mice.

What appears to be a still more remarkable instance of medical knowledge is the sacred scarab beetle of the Egypt of the Pharaohs. The scarab beetle was considered sacred, and the commonest form of ornament was made in the shape of this beetle. You find scarab ornaments everywhere in Egypt; in the necklaces of precious stones, in clay ornaments, in inscriptions, in diadems, and on the walls of the tombs and temples.

Now the scarab beetle is not a particularly pretty or ornamental insect, and his habits are disgusting, as he lives on, and in, human and animal excreta. It is his favourite diet and his permanent home. At first sight, therefore, it seems odd that this particular beetle should have been made sacred and had so much attention paid to it, as was obviously the case in ancient Egypt. But one of the greatest curses of ancient Egypt, as it still is of modern Egypt, was the hook-worm; a parasite which causes untold misery and which renders those who become infected with it chronic invalids, and most seriously saps their vitality for years before it kills them. The hook-worm parasite has a life cycle or series of lives, one of which is in man or animals, the next in the excreta or manure of the infected individual, and lately in water from which it is again able to enter the bodies of human beings and animals. It is obvious that if this cycle can be broken anywhere the hook-worm will die out, and an insect who habitually eats excreta, and whose business in life is to collect and bury it, will do a great deal to check the hook-worm parasite, even if it does not succeed in entirely exterminating it.

It seems hardly probable that the sacredness of the scarab beetle was merely accidental. This particular beetle is neither rare nor beautiful. It is the common dung beetle that is found in most parts of the world, and like the snake rather repulsive than

otherwise. That there was a deep meaning for the sacredness of this beetle in ancient Egypt, and that it was, like the cat and the snake, made sacred with special design, would seem the only reasonable explanation.

The plan of making things sacred in order to protect them from destruction was much used in ancient times, and was certainly more effectual than our present method of imposing a small fine. The sacredness of the cow in India arose from the fact that serious famines due to failure of the crops have from times immemorial been a common occurrence, and that when there was nothing else to eat the peasants killed their cows. This resulted in the almost complete destruction of cows over very large areas, and after the famine was over there were no cows and consequently no milk for the children and domestic purposes. It often took generations to re-establish the cow population. The cow was, therefore, made sacred by the Hindus, and even people dying of starvation could not kill one. Even to-day to kill or injure a cow is a most serious offence. When I was in Nepal, there was a native chauffeur who had accidentally run into a cow with his car and killed it. He had been sentenced to death, and all the Maharajah had been able to do in mitigation of a sentence with which he did not approve was to alter it to imprisonment for life.

Modern medicine may be said to have begun among the Persians and Greeks, and it gradually spread to Europe during the Italian Renaissance, but the old knowledge appears to have been entirely lost and even as late as the Plague of London in Charles II's time no one knew as much about plague as the priests of Babylon knew 4,000 years before.

In the course of classical times medicine and surgery had many ups and downs. The first really rational school of medicine began in Greece under Hippocrates, and it is indeed doubtful if until comparatively recent years any subsequent surgeons equalled Hippocrates in the treatment of wounds or in the accuracy and truth of his observations. When we consider the very limited knowledge of the anatomy of the human body that existed at that time, it is surprising that the development of surgery in the Hippocratic school reached such a high standard.

Clean wounds were expected to heal by primary union, that is, without becoming inflamed and suppurating, whereas almost without exception all subsequent surgeons up to the time of Lister believed that suppuration of the wound was necessary.

The Hippocratic school taught that clean wounds should

be washed with boiled water and dressed with new linen and that the surgeon should keep his hands clean.

The medical knowledge of the Romans was adopted from that of Greece and they do not seem to have added much to medical practice except in that they encouraged the best Greek traditions.

The craft of medicine was flourishing and of a high order, even by our modern standards, during the last century B.C. and the first A.D. Many of the surgical instruments unearthed at Pompeii and Herculaneum are almost of the same design as those now in use and they were buried with the cities in A.D. 79.

The religious quacks which dominated Europe in the fourth and fifth centuries drove most of the culture of ancient Greece and Rome to Persia. Nestorius and his followers were persecuted as heretics because they thought that the Virgin Mary should be called the Mother of Christ and not the Mother of God, and they were obliged to flee from Constantinople. In this way was founded the famous Persian School of Medicine.

This school wrote many works of medicine which helped to keep alive the Hippocratic knowledge. As doctors and surgeons they were probably more famous for the books they wrote than for their practice. The treatise of medicine written by the Persian physician Rhazes consisted of twenty-five volumes.

The art of medicine suffered a serious setback in the thirteenth and fourteenth centuries owing to the outbreaks of plague which devastated vast areas at that time. Why these terrible epidemics took place we do not know. There had on many occasions been outbreaks of epidemic disease among the armies of conquerors and among the crowds of pilgrims who took part in the Crusades, but history does not record outbreaks with such fatal and widespread consequences as the Black Death, which almost depopulated Europe in the fourteenth century.

The physicians and surgeons of that time were quite powerless either to treat the disease effectively or to suggest any practical manner by which it could be avoided, or the contagion be prevented from spreading to fresh areas.

Many of them refused to attend the sick for fear of contracting the disease themselves, and this, coupled with their complete incompetence to help the patients, discredited the medical profession as a whole. Though it must be recorded that there were many brave men among the physicians of that time, who, in spite of the risk, continued to attend the plague-stricken.

The plague epidemic which struck Europe in 1347-50 came

from the East. It is said that India was almost depopulated and that thirteen million persons died in China. An infected ship brought the disease to France and it soon spread all over Europe. At Avignon, for instance, three quarters of the population died in the course of a few months. It rapidly spread from one country to another and in the course of three years or so had reduced the population of Europe by a third. Whole towns and villages were depopulated and trade and business was brought to a complete standstill.

Against serious disease doctors were quite helpless until comparatively recently, say one hundred years ago or less. Diagnosis was almost entirely empirical, mainly founded upon experience of similar cases, and treatment with one or two exceptions consisted of bleeding and the administration of mercury.

The physician of those days wore elaborate morning clothes and carried a gold-knobbed malacca cane, which was almost a badge of his profession. The so-called "bedside" manner was then in its prime and indeed was the physician's greatest asset, for, apart from impressing the patient and his relatives with his profound knowledge and acumen, he had little more to offer in the way of treatment; indeed not infrequently such treatment as he did prescribe was more likely to make the patient worse than better.

He seldom failed to order a bleeding, which, while it might benefit a few forms of heart disease, and some cases of apoplexy, was certain to do harm in acute infections, and most other conditions.

Mercury was almost invariably prescribed in all acute infections, such as fevers and pneumonia, and was pushed in such large doses that the patients' teeth became loose, and the spittle ran from his mouth.

Nor was surgery in much better case. The surgeon a hundred years ago had to operate upon conscious patients who had to be held down on the operating table by two powerful porters, assisted by straps round their limbs. It took a man of exceptional moral and physical fibre to perform major operations upon a screaming patient, and everything in the execution of the operation had to be sacrificed to speed. It is recorded that Chiseldon could cut a stone from the bladder in fifty-three seconds, and Liston could amputate a leg through the middle of the thigh in a minute and a half.

Strength, speed and dexterity were essential for a successful

surgeon, and even when he had succeeded in performing the operation and controlling the bleeding, three-fifths to four-fifths of his patients died in the next few weeks from sepsis, gangrene or blood poisoning.

The mortality from operations of almost every kind varied from fifty per cent to over ninety. It was estimated that the chance of patients in one of our great hospitals surviving an operation a hundred years ago was not more than one in three, even if they were fortunate enough to fall into the best hands.

The discovery of chloroform and ether, while it did away with the worst horrors of the operating theatre, did not reduce the mortality from sepsis, and hospital gangrene still claimed the majority of patients, until Lister demonstrated that post operative sepsis was preventable.

In those days Caesarian section had a mortality of ninety-cight per cent both in England and elsewhere, and to-day it is about 1.3 per cent or less, and the risks of operations have been so reduced that they are probably to-day not so great as those of crossing a public street.

The healing art has made marvellous strides within the last hundred years, but it is only at the beginning, and no one can predict what advances will yet be made.

CHAPTER XXI

MEDICINE AND MAGIC

MEDICINE, or the art of healing, has been associated with magic since the human race first began to think. All the early prescriptions contain ingredients that are obviously included for their value as charms or magic. Such substances as mandrake gathered at midnight or at the full moon, female frog legs, the dried blood of a female horse, cauls from a child's birth, spiders' webs, asses' milk, goats' dung, frogs' blood, and many other ingredients commonly used in old prescriptions are obviously only included for their supposed magical properties.

These and hundreds of other peculiar and unpleasant substances, were frequently used in medicine, and although we cannot tell with exactly what object they were included we may safely assume that magic was the reason. Even the sign R/ that is to-day put at the beginning of a prescription is a sign of luck or to keep away the devil.

Nor indeed have modern science and modern education succeeded yet in divorcing medicine entirely from magic. When electricity was first invented it was immediately seized upon by the quack practitioner and vaunted as a remedy for almost every kind of disease. It is still extensively so used, and enormous sums of money are made annually by the sale of electric belts, magnetic rings and by treatment with various forms of electricity, though there is almost a complete lack of evidence that electricity, as such, is of the very slightest use in the treatment of disease.

Sunlight and ultra violet rays are very popular just now as forms of medical treatment, but except for a very limited field they come rather under the head of pseudo magic than scientific treatment, and most of the benefit that patients get from such treatment is due to their faith in the magical results, rather than in direct benefit.

The doctor who prescribed A.D.T. mixture to his patients, which on investigation was found to stand for "Any damned thing," well understood the magical value of a bottle of medicine. Many patients, even in these days, attach quite unwarrantable importance to the taste or colour of a medicine, irrespective of the fact that the taste is probably inserted merely to disguise some other taste and the colour has probably nothing to do with the ingredients at all. Many medicines in the older pharmacopœia were made to taste unpleasant because many patients had no faith in a medicine unless it had a nasty taste. I remember an old lady, who was a chronic attendant at a Hospital Outpatient Department, complaining that the last bottle of medicine which she had been given was not so good as that she used to have, and on investigation we found that it was exactly the same except that aloes, which gave it a horrible bitter taste and had no other effect, had been left out.

Many quite intelligent people wear a fiddle string round their waist next to their skin because they believe it keeps away neuralgia, or carry a nutmeg in their pocket to ward off lumbago. If this is not a belief in magic, what is it?

The advertisement columns of our newspapers are full of patent medicines whose appeal to the public is based on magic rather than therapeutics. Now and then we read something original, but the common old story is that the particular drug was discovered by an Indian and given to a white man as a great secret because he was kind to him when he died. It is always highly praised because it contains only vegetable matter, though why we are not told, nor is there any valid reason why a vegetable drug should be more efficacious or less harmful than a mineral one; as a matter of fact all the most deadly poisons are vegetable. Why also it should be an Indian, we do not know. The public, or at least that part of it which buys such medicines, appear to have more faith in drugs which have been discovered in South America than in a modern laboratory, where as a matter of fact nearly all the drugs come from.

There would appear to be a certain cult in this matter. Face

Creams to preserve or remedy the complexion were discovered mostly in Egypt, presumably by Cleopatra. Hair restorers generally emanated from some wise woman in a country village. Occasionally a great doctor is supposed to have discovered them; needless to say, he is always dead, because if he were alive he would probably bring an action for libel, but a dead man cannot do this.

No, the public love being fooled and the days of the quack and the medical charlatan are far from over. It has been computed that three times as much money is paid annually by the public for quack remedies and treatment than is paid to the medical profession.

If someone were to advertise clearly and extensively in this country that a marvellous stone had been discovered, say in Tibet or at the South Pole, which had the effect, if worn round the neck, that it would infallibly prevent cancer, it would have an extensive sale. The advertisement would, of course, state that there is only a small quantity of this valuable stone and, therefore, the supply being limited, it is not possible to sell it to the public cheaply. The story of how an old, shrivelled Tibetan woman with six husbands took the explorer through the snow to a wild pass in the Himalayas and pointed out the spot where the stone could be obtained would doubtless form part of the "copy". Testimonials as to its value as a preventive of disease would be given from missionaries, clergymen, and possibly a colonel or two, and a peer's name would appear on the board of directors of the company. The result would be a colossal sale, provided the advertisement were sufficiently well written and displayed, for the public have not lost their belief in magic. Moreover, since only about one person in seven or eight of the population ever gets cancer there is a seven to one chance of the stone being successful, the one in seven failure would no doubt be easily explained away.

The modern quack is very ingenious, and thoroughly understands the value of magic; some of his methods show cleverness worthy of a better cause. Recently one such gentleman, who posed as a heart specialist, used to tell clients that he knew what was the matter with their heart: it was a rare condition which the legitimate doctors had not discovered. There were hairs growing on the valves of the heart and interfering with the proper working of that organ. He could put it right; they must take daily some capsules he would give them to swallow and in a few days the hairs would get loose and fall out. They would know if the

treatment was being successful because they would see the hairs in their stools. This proved to be quite correct and it was not until some client, who was inquisitive enough to open one of the capsules, found that it was full of hairs, that the fraud was discovered. The simple anatomical fact that by no possibility could hairs in the heart find their way into the intestine did not matter, as the vast majority of the public do not know even the most elementary facts about their own bodies.

Another equally ingenious quack advertised that he had discovered how to cure gallstones by a simple medicine. Very many people went to him, for the legitimate profession know of no means to cure gallstones by medicine. The patients were put on a regime of olive oil and some medicine which probably contained soda, and were told that if the treatment was successful they would pass the gallstones without any pain. In due course this came true and large numbers of what appeared to be gallstones appeared in their stools, to the great satisfaction of the sufferers who believed that now they had got rid of the stones they would have no more symptoms. An analysis of some of the supposed gallstones, however, revealed the fact that they consisted of soap. The combination of olive oil and the medicine resulted in the formation of little lumps of soap in the intestines, which in the course of their passage down the bowel came to resemble gallstones so closely in appearance that they were indistinguishable except on analysis.

As quacks work on the system of fooling most of the people most of the time, they do very well, and if their methods are sometimes discovered to be frauds it does not matter.

When magic is associated with religion as a means of curing the sick, the appeal is much more effectual. We have evidence of this in the thousands who flock to Lourdes and the Black Virgin at Chartres, and many other places. While in Asia and Africa the natives have far more faith in miracles than they have in legitimate medicine. Dirty water from Lourdes and the Ganges can be sold at high profits, even in London and New York, and the day of the magnetic ring and the electric belt has not passed away yet.

CHAPTER XXII

QUACKS AND CHARLATANS

MEN and women who have posed as being able to cure diseases or to perform miracles have generally, in all nations, been labelled quacks if they have not been trained by the medical faculty of the time and place, or have not been willing, or able, to conform to the rules and regulations of the guild or corporation of medicine or surgery of their country.

There have been many most successful quacks, who have made large fortunes by exploiting public ignorance and credulity, and not a few have been really able men, who have done good rather than harm. One of the most famous was Sir William Read, who looked after the eyes of Queen Anne and had the standing of Court Surgeon. He had a very large practice, due largely to the fact that the surgeons of that time disdained to pay any attention to maladies of the eyes and considered all those who did as charlatans.

Some of these eye doctors were quite well qualified. The Chevalier John Taylor was the son of a surgeon and had received the ordinary medical education of the time. He was appointed Oculist-in-Ordinary to King George II.

Most of the operations for stone in the bladder were performed by travelling itinerant quacks who called themselves "cutters for the stone" before the time of Chiseldon, who specialised in this type of operation and first made it popular among the surgical fraternity.

One of the most outrageous frauds was Joanna Stephens, who in the beginning of the eighteenth century claimed that she had a secret remedy by which stones in the bladder could be dissolved, so saving the necessity of an operation for their removal. She made a lot of money and then offered to sell her secret prescription for the sum of £5,000.

It seems amazing that a public subscription was started for this purpose and that the Government of the day offered to pay the £5,000 if a Commision reported favourably. It appears that the Commission did so report and Joanna in due course was paid her money from the public funds.

The famous secret remedy proved to be quite worthless and to consist of such ingredients as soap, egg-shells, swines' cresses and honey.

Cagliostro was one of the most successful of all quacks. He and his wife travelled all over Europe promising, and one must assume occasionally actually performing, miracles. He claimed to be able to raise the dead, of course for a suitable fee, to make pearls and diamonds grow larger, and ugly women beautiful. He was a pure impostor, who relied upon a good address and being able to impress his audience with the truth of his statements. In these days we should describe him as a confidence trickster. He sold a grandee of Spain the receipt for the Philosopher's Stone which would turn base metals into gold and departed next day to another country.

In spite of the fact that he was imprisoned on several occasions he enjoyed a great success until he got mixed up with the affair of Marie Antoinette's diamond necklace. For this he was tried, but released, as innocent. It proved his undoing, however, and he ultimately fell into the hands of Spanish Inquisitors and died in prison.

There are more quacks to-day than there have ever been. The public is just as credulous as it ever was, and modern means of advertising and propaganda enable the quack to-day to reach a much larger public than was ever possible before. To-day quacks flourish in all countries, but America seems to be their happy hunting ground.

Their principle is to pretend to be able to cure some disease which the legitimate practitioners are unable to cure, such as cancer, or some disease for which there is no cure except by operation, such as gallstones.

The sale of quack medicines of one kind and another is larger than that of the legitimate variety and new ones appear almost daily. The public never stop to think that patent and quack medicines cannot contain very potent drugs, for the very good reason that such drugs must be dangerous to some people and an action for damages could be brought against the vendors. Most of the more valuable drugs that are used as medicines are dangerous, and occasionally cause distressing or even dangerous symptoms. Most patent medicines, therefore, contain nothing that could under any circumstances prove dangerous, or if they do the dose is so small that it is almost impossible for the medicine to cause either good or harm.

The public have at any rate been thus safeguarded against

danger from quack remedies, even if they still continue to waste vast sums of money annually in the purchase of such medicines, and the State gets a good "rake off" by charging a fee upon the sale of all patented medicines.

The "bone setters," who claim to be able to cure all sorts of maladies by manipulating the spine, have had a good innings and seem still to be going strong. They claim that one of the small bones in the spinal column has become displaced and that it is pressing on some nerve or muscle and so causing the pain or disability from which the patient suffers. It matters very little what the particular ailment may be. Thus deafness, headaches, noises in the head, loss of sight, may all apparently be caused by the displacement of one of these small bones, and may be remedied by manipulation of the spine to correct the displacement. Needless to say the manipulation will have to be repeated a good many times and the fees are very considerable.

It is surprising how apparently quite intelligent people fall for this rubbish, and how successful such quacks are. One hears of wonderful cures that are supposed to have occurred, in spite of the fact that there *are* no small bones in the human spine that can be displaced under any circumstances. I have known people who refused to be convinced, even though shewn an X-ray photograph of their own spine.

Some of the most successful of the old bone setters were those who broke down adhesions in joints. Until recently legitimate doctors did not understand the danger of adhesions forming in joints after fractures and injuries. The limb or joint was placed in a plaster of Paris splint often for many weeks and the delicate surfaces in the interior of the joint stuck together as the result of the inflammation which resulted from the injury. As a result when the splints were at last discarded the patient could not bend the joint properly, and had acute pain when he attempted to do so.

To-day this is well known and adhesions are not allowed to form, or if they do, the patient is given an anaesthetic and the adhesions are broken down, with immediate relief. But it is only within the last thirty years that the importance of preventing adhesions in joints has been recognised, and before that time there were many people with joints which were crippled because of such adhesions.

The "bone setters", as they called themselves, claimed to be able to cure such cases, and they undoubtedly did succeed when the case was really one of adhesions and there was no disease of

the joint. Unfortunately they were as a rule unable to distinguish between those cases due to disease and those due to adhesions, and if the case was one of disease of the joint their manipulations caused disastrous consequences.

Being quacks they could not obtain the services of anyone qualified to give an anaesthetic to the patient, and they were as a rule afraid to administer ether or chloroform themselves in case the patient might die, so they had to resort to dexterity and surprise to take the place of the anæsthetic.

In the case, for instance, of an elbow which could not be straightened owing to adhesions from a previous fracture or injury, their method was as follows:—

The "bone setter" seated the patient in a chair and then standing behind him took a firm grip of the forearm just above the wrist with one hand and of the upper part of the arm with the other hand. Then having obtained a firm hold he slowly but forcibly bent the arm at the elbow. The patient expecting severe pain from having the arm manipulated naturally resisted this bending movement, and when the "bone setter" realised that the patient was exerting the maximum of resistance to having his elbow bent he suddenly snatched it straight. In this way he forcibly broke down the adhesions in the joint and the patient quite unwittingly assisted him. The pain at the time was very severe, but in a few

days the patient would find he could move his arm quite readily in all directions without pain.

Many of these "bone setters" enjoyed a great reputation and they undoubtedly did good in many cases, though in a few they did great damage. To-day there is not much practice for them because legitimate doctors know how to prevent the formation of adhesions after a fracture or injury, and even when, as sometimes happens, adhesions do form, in spite of their efforts to prevent them, they can easily remedy the condition after administering an anæsthetic.

CHAPTER XXIII

CELLS

All living things, whether animal or vegetable, are composed of a great number of cells or minute compartments fused together to build up the whole structure of the organism. These cells are units, as the bricks are the units that when placed together form a building. Living cells are so small that they are invisible to the naked eye and can only be seen with a powerful microscope, and the total number of cells of one kind or another that are present in a single human being run into countless millions.

Yet each of these cells is an independent unit of life which is born, lives and dies in its own place and time. Although dependent on the other cells around for most of its activities and even for its continued existence, it has a separate and individualistic life of its own.

These units or cells differ from each other according to the particular tissue of which they form part, though there are a great many similar cells in any one tissue. Some, such as those in the central portion of the retina of the eye, are very highly specialised to fulfil their particular function of detecting light rays of different colours, density and intensity; and the same is true of the brain cells, muscle cells, and the secreting cells of the glands.

All these cells are particularly adapted to fulfil the special function they serve in the economy of the entire organism.

The actual size of the individual cells does not vary very appreciably; thus the cells which go to make up an elephant are about the same size as those of the mouse. One might reasonably have supposed that the cells of the mouse would be miniatures of those of the elephant, but such is not the case. It would appear that for all living things there is an optimum size for the constituent cells, which varies very little throughout the animal kingdom.

It was not until the microscope was discovered that it was possible to see that the tissues of which the body is composed are made up of numbers of single cells.

Since the discovery of the microscope, however, great interest

has been taken in the study of the different cells in living tissues, and the way in which they are arranged in relation to each other. The microscopic study of cells is called histology.

The usual method of studying cells is as follows. A piece of fresh tissue is taken and is placed in alcohol or formalin to fix it. It is then dried and placed in melted paraffin wax and kept in the hot wax till the latter has completely soaked into it. Then the wax is allowed to cool and become solid, when a small block is cut out containing the piece of tissue. This block of wax is now placed in an instrument called a microtome and very thin shavings are cut off it with a razor blade. The microtome is so constructed that exceedingly thin slices of the tissue which is embedded in the wax can be cut off in layers.

One of these thin slices is now placed on a glass slide and the wax dissolved away with a suitable solvent, leaving nothing on the glass slide but the thin slice of tissue. This is now stained with some dye which is selective in that it will colour certain parts of the tissue and not others. The surplus dye is washed away and the water, if any is present, got rid of with alcohol; then a drop of Canada balsam gum is placed over the piece of tissue and a very thin flake of glass, called a coverslip, is pressed down over it till there is nothing except the piece of tissue between the two layers of glass.

The glass slide can now be placed in a microscope and viewed as a transparency under a strong light, and the details of the piece of tissue magnified many hundreds of times.

A well-cut section will be no more than one cell thick and the individual cells can be examined and their characters studied.

This is the way by which most of our knowledge of cells has been acquired, by examining very large numbers of such sections of growing tissues at various stages.

A great deal has been discovered of the manner in which tissues grow, how the cells wear out and are replaced, how they function and how they are related to one another, but this method of studying living cells is very laborious, and in many ways unsatisfactory, because movements cannot be seen to occur in the cells and can only be deduced from an examination of very many pieces of tissue in different stages of activity.

Living cells have been watched under the microscope in the living state in the web of a frog's foot and in the thin part of a rabbit's ear, where the tissue is sufficiently thin to be seen through with a powerful light.

By such means the circulation of the blood in the smallest blood vessels has been studied, and the processes involved in inflammation were thus discovered.

The discovery that living cells can be kept alive outside the body to which they belong has opened up a new field of research, and has very greatly increased our knowledge of the way in which cells divide and function in relation to each other, and to outside influences.

Minute, living pieces of tissue, if transferred under strictly aseptic precautions so as to prevent any possibility of contamination by organisms, can now be kept alive in drops of suitable solution hanging from the under surface of a glass slide. The glass slide from which the drop hangs must be kept at body temperature in an incubator and a fresh solution must be added to the drop daily to provide the nutrient substances necessary for the tissues to live and grow.

The drop must also be protected from evaporation and from any source of infection from the air. This is done by keeping it in a small glass chamber.

This all sounds very difficult and involved, but the technique necessary to preserve such minute pieces of living tissue for long periods has been perfected, and there are at the present day in some research laboratories pieces of living heart muscle that have lived for years after being removed from the animal to which they originally belonged, and can still be watched contracting rhythmically as they did in the heart from which they came.

This method of research is known as "in vitro culture" and has proved a most valuable means of studying living cells. The slides with the hanging drops can be placed under a microscope at any time and the living cells watched. They can be seen during the process of division and the *modus operandi* of this strange phenomenon observed. The changes that occur in living cells are slow and such studies involve very many hours of patient watching with the observer's eye at the eye piece of the microscope.

More recently it has been possible to make photographs through the microscope of the living cells at regular intervals. The hanging drop is kept under the microscope lense under conditions which enable the cells to grow and develop, and attached to the eyepiece of the microscope there is a cinema camera which by a clockwork device takes a photograph every thirty seconds or at such intervals as may be desired. The whole apparatus works automatically and when the complete reel of film is exposed and

developed, the pictures can be thrown on a screen, enormously enlarged, as a cinematograph moving picture. We can thus not only see the movements of the microscopic cells enormously enlarged, without it being necessary to look through the eyepiece of a microscope, but we can overcome the time factor and see in a few moments events that in reality extended over several days.

The individual cells, when the film is projected on to a cinema screen, appear as large as bath sponges and they can be seen to move about and undergo division.

This method of studying the behaviour of living cells was, I believe, first made use of by Messrs. Pathe Freres, but the late Dr. Canti, working under a grant from the British Empire Cancer Campaign, perfected the method and made it possible to study living cancer cells and watch their reaction to the rays of radium and certain drugs and sera.

When one watches living cells in the cinema screen that have been photographed in this manner through a microscope, one is immediately conscious that one is seeing something that cannot be appreciated when watching the cells with the eye through a microscope. The movements of the cells are so slow that when watched by direct vision their significance is not apparent, and their movements appear haphazard; but when the time factor is altered by means of cinephotography, one is at once struck by the fact that the cells exhibit marked individualism in much the same way as organisms.

In the Canti film one is able to see fibroblast cells, cancer cells, embryo cells and spleen cells growing and moving about together, and one notes that the individual cells of different kinds vary both in appearance and behaviour.

Some move more freely than others, some attack and destroy other cells, even seeming to chase them about until they catch their victims, some die more easily than others, and so on.

There are all kinds of differences between the individual cells which cannot be appreciated when they are viewed by direct vision.

The process of division, by which one cell becomes two cells, is most beautifully demonstrated by this method. The normal time for the division of a cell is from twenty to thirty minutes, but in the film this process only takes about one minute, so that it is quite easy to observe the whole process from the beginning when the nucleus of a cell begins to get cloudy until it has divided into two halves and two complete independent cells have formed.

There are still many things in living cells which cannot be seen since they are too small to be viewed, even with the most powerful microscope, and unfortunately the wavelength of light sets a limit to the possibility of seeing objects smaller than a certain size, no matter what microscope is used.

The genes or units which determine the hereditary factors of the cell have been calculated to be about the same size as a protein molecule and there is little hope that they will ever be seen and what we know about them has been determined by deduction.

It is, however, certain that the cell is not the limit of life but that there are within the cell many thousands of other units which determine the behaviour of the cell and, if it is a dividing cell, of all its progeny, what they will do, what their character will be, and in fact what they will develop into. The character, appearance and behaviour of a child depends upon the genes in the cells of its parents.

It will thus be seen that although it is customary to consider the individual cells of which the body is made up as the units, there are in fact other and more minute units which we call genes present within the nucleus of the cell, and it is possible the genes themselves may be made up of still smaller particles.

The study of living cells by the method of "in vitro" culture is now being extensively pursued in laboratories all over the world, and there can be no doubt that it will result in a very great increase in our knowledge of the manner in which living tissues function, how they develop, and the manner in which their activities are all synchronised for the ultimate benefit of the organisms of which they form a part.

It also makes it possible to observe the reaction of the tissue cells to various kinds of beneficial and noxious stimuli, and so to study the beginnings of those conditions which will eventually develop into disease and what we call illness.

CHAPTER XXIV

SEX DETERMINATION

EVER since man began first to take an intelligent interest in the breeding of his own children, or the progeny of his domestic animals, he has sought some means by which he could control the sex of the offspring of his matings. In breeding children there has always been a strong preference for sons rather than daughters. Sons to succeed to titles or estates, to help in the hunt, to assist on the farm or in the family business, to carry on the name and consolidate the family. In China a man feels disgraced if he has no son to worship at his shrine after he is dead, and so useless are girl children considered that at one time it was a common practice among the poorer Chinese to throw away the female babies and not attempt to rear them. Even to-day among civilised people it is looked upon as a real misfortune to have a lot of female children in the family. In many countries also male children are looked upon as a great asset to the State, since they can, if the necessity should arise, be used as what the Germans euphemistically call "cannon fodder."

The determination of sex in domestic animals has been no less important. In breeding cattle the farmer wants cows, in order that he may sell their milk, and has so little use for bull calves that he usually kills them and sells the skin for what it will fetch, as the bull calves, unless the parents are valuable pedigree animals, are almost valueless. Much the same is true of dogs; most breeders destroy the bitch pups, keeping only an occasional one for future breeding purposes.

It has naturally resulted that all through the ages man has tried to discover some way in which the sex of the future offspring can be determined before conception.

Prayers and offerings to the gods for male children was a usual practice in early times, and certain Goddesses existed solely for this purpose. As the priests were not slow in realising the benefit to the temples that would result from offerings for male children by prospective parents, they exploited this chance, and since the chances were in any case even, they did very well out of it. Half of those who consulted the goddess obtained what they wanted, and it was easy to find excuses for failures.

CHAPTER XXV

HOUSING

IT has been generally assumed that man was originally an animal living in the trees and that at some period—it has been suggested as the result of the destruction of the forests in the early glacial periods—he was compelled to live on the ground in caves and shelters among the rocks. It is quite possible that primitive man never at any time lived in trees.

If we can confine ourselves to the only evidence that exists we find the first traces of man in caves. Evidence that man lived in caves millions of years ago has been found in very many parts of the earth from England to China and South America. Among the debris found at the bottom of caves which it can be proved have not been disturbed for vast ages, evidence of man has been found in the shape of ashes, burnt sticks, rudimentary crockery, worked stones and flints, rough drawings and designs on bone, and wall decorations.

There is in fact evidence that primitive man lived in caverns in the remote past, but none that he lived in forests.

It is, of course, evident that, apart from resemblance to the monkeys, there can be no means of proving that man was once an arborial animal. But it is at least possible that while monkeys in the course of evolution took to a life in the trees, man remained a ground animal.

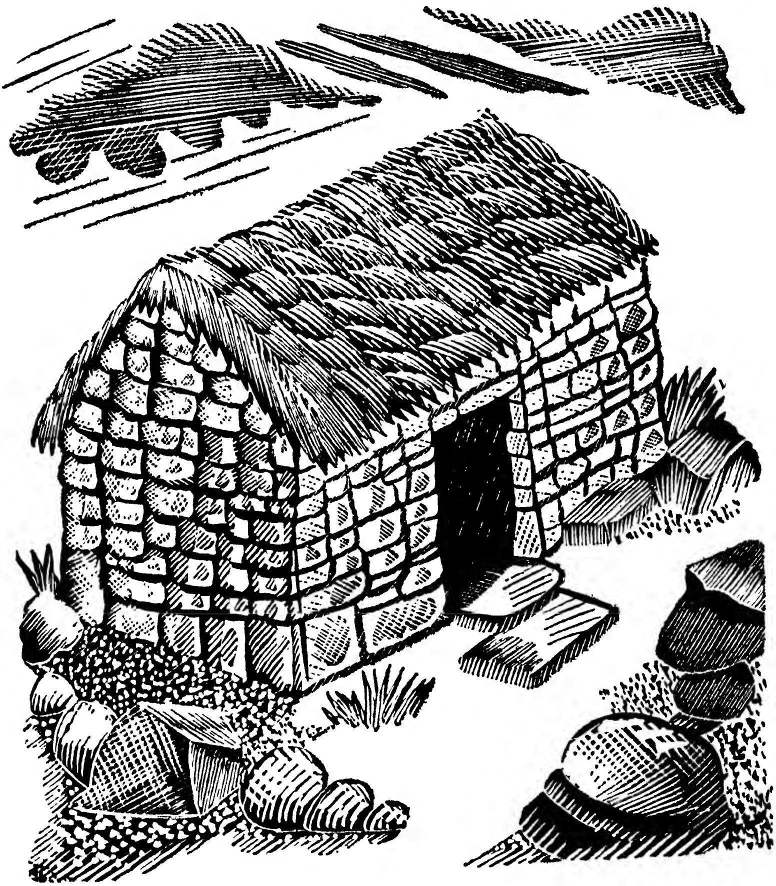
There is certainly no evidence to the contrary, and in favour of such a view is the fact that without exception apes and monkeys are pure vegetarians living on fruit and leaves, while man is a mixed feeder and a carnivore, requiring meat as part of his diet.

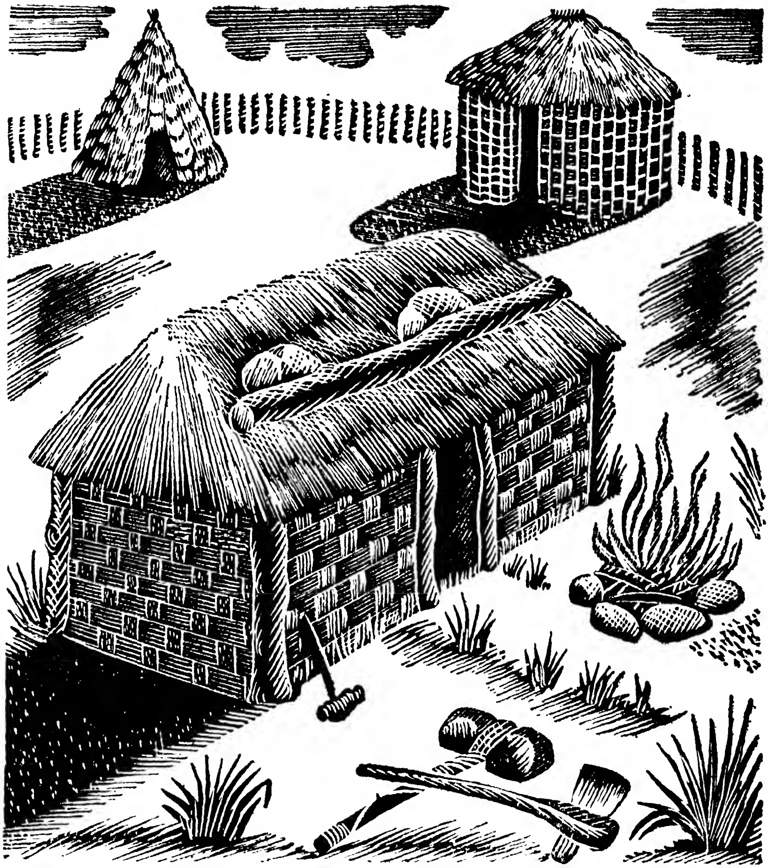
The advantage of living in caves was that he was protected against cold and wet, and also could store up food. He and his relatives could thus avoid the danger of becoming a meal for one of the larger carnivora.

The first step towards the building of a house probably arose from attempts to close the mouth of the cave with stones so as to form an entrance which could be closed. It was an easy transition from this to the building of walls by fitting together rough stones

and making, as it were, an artificial cave. The convenience of being able to have ones cave where one wanted it must have rapidly popularised the construction of stone walls, either to form rough huts or to extend or adapt unsuitable caves.

The earliest houses must have been made of rough stones placed together so as to fit roughly to form walls and roofed over with logs covered with reeds or large leaves. Even to-day many of the crofters' cottages in the Scotch Hebrides are so constructed, with no cement except mud pressed between the stones to keep out draughts, and with the roof held down by ropes to the ends of which big stones are attached.





When primitive man succeeded in improving his tools and could manufacture stone or flint axes by means of which he could fell the forest trees, he was at last able to construct wooden houses. It seems probable that his earliest efforts in this direction resulted in the construction of the lake dwellings, evidence of which have been discovered in many parts of the world. Wooden

platforms were constructed, built on rough piles in the lake, and on these huts were built. The advantages were protection against the attack of wild beasts afforded by a narrow causeway between the land and the platform, which could be blocked by a gate or could be altogether removed at night.

The lake dwellings also solved the problems of a water supply and drainage, which must have been a serious nuisance in the cave dwellings.

For thousands of years the only materials available to man for the construction of houses were stones, skins and wood. Who the genius was who first made the epoch-making discovery that if soft clay is moulded into a brick and hardened by exposure to a hot sun it can be used to build walls, we shall never know, nor has anyone apparently ever put up a statue to him, but his wonderful invention was to prove of untold value to the human race.

The great civilisation of Babylon and the Plains of the Tigris and Euphrates could never have come into existence unless the way to make bricks had been discovered, since there is no stone within hundreds of miles and very little serviceable wood. It is possible that the great discovery was first made in this part of the world; at any rate the first cities made of brick appear to have originated near Ur of the Chaldees, near the mouth of the Euphrates.

The discovery of the way to make bricks made possible the building of vast cities. The fortunate circumstance that bitumen, a form of pitch, existing naturally in large quantities in this part of the world, made a suitable binding material for the bricks, rendered the construction of walls a comparatively simple process. The use of cement to hold the bricks together was not known at that time, nor was there any chalk in Babylonia from which it could have been made, but the bitumen was just as good for the purpose and existed on the spot in almost unlimited quantities.

The size of some of the buildings that the ancient Babylonians constructed with bricks are so stupendous that many people have not credited the descriptions that have come down to us of their measurements. The largest single building of ancient times is generally believed to be the Pyramid of Cheops in Egypt, but if we are to believe the historical records of the walls of Babylon the Pyramid was easily surpassed.

The ancient City of Babylon, the greatest city of ancient times, is said to have measured some 80,000 yards, or forty miles, in

circumference, and the walls are given as being 200 Royal cubits high and fifty wide. A Royal cubit was 20.89 inches, so that the walls must have been some 350 feet high and about eighty-seven yards wide. These are truly colossal proportions for any walls, much more so for walls built of sun-dried bricks. It seems quite incredible that such an enormous mass of masonry could have been built over four thousand years ago of ordinary clay bricks, but the measurements given by ancient historians, such as Strabo and Diodorus, all agree fairly closely. Thus Diodorus gives the circumference of the walls of Babylon as 360 stadia, Strabo as 385 and Clatarchus, who went there with Alexander the Great, as 365. If we are to believe the measurements of these ancient historians the tops of the walls of this colossal city must have been nearly as high from the ground as the top of the Dover cliffs are above the waters of the Channel. No wonder the City of Babylon was considered one of the wonders of the world.

The colossal buildings in the form of pyramids and temples, the remains of which can be seen in the Valley of the Nile, are all constructed of granite and consequently almost indestructible, whereas the vast buildings of the ancient Babylonians were all made of sunbaked bricks held together with pitch, a method of construction that, though serviceable enough for a time, must have called for constant repairs, and in the course of a few thousand years have almost entirely disintegrated, so that even the foundations of the City of Babylon cannot be traced with any accuracy.

The peculiar conditions existing in the Nile Valley, that resulted in the complete flooding of all the habitable areas near the river for several months each year to a depth of many feet, precluded the building of permanent houses for the inhabitants, nor were such structures necessary in the Egyptian climate. At any rate we do not find any ruins of houses, or even Palaces, in the Nile valley, but only of temples which were constructed of such enormous stones that the annual flooding caused no material damage. The level of this flooding can still be seen on the columns of the Temple of Thebes at Luxor, and is some twelve feet above the pavement. The houses of the inhabitants were probably wooden structures which could be removed when the floods came, or easily rebuilt after the flood had subsided.

The actual method of construction of the pyramids is not known very exactly. The blocks of granite composing the great pyramid are rectangular weighing five tons each; they are fitted

together without cement and fit so accurately that a visiting card cannot be pushed anywhere between them, and yet they were cut out without the aid of steel or iron, the only tools being made of bronze. Whether the Egyptians used some form of primitive crane to hoist each block into position, or relied entirely on dragging them up the sloping ramp, we do not know, but the knowledge of architecture and engineering displayed in the building of the larger pyramids is extraordinary.

It is believed that the stones were quarried near the banks of the Nile and floated down to the site of the pyramid on rafts during the time when the river was in flood, as at other times the river would be several miles away from the situation of the Pyramids. Actually at the present day the Pyramid of Cheops is some eight miles from the nearest part of the Nile.

The Pyramid of Cheops was built by one hundred thousand men, and it is believed that the stones were cut and trimmed on the site by means of bronze saws set with diamond teeth. This pyramid is over 500 feet high and the actual error in construction of this gigantic mass of stone, as measured by most accurate modern instruments, is only 0.65 of an inch. It is obvious that the great stone blocks must have been squared and surfaced with amazing accuracy, or in a structure of over 500 feet in height a considerable error must have developed, as the blocks rose one upon the other into the sky. The minutest error in one of the lower layers of blocks would be exaggerated until in the upper blocks it would be quite serious. But the architects of that time were very careful workmen and made no mistakes; no doubt a mistake in those days involved some drastic and unpleasant form of punishment.

One of the most extraordinary buildings that has ever been constructed is the Parthenon at Athens, which was built by Pheidias and completed in 438 B.C. So cleverly has it been designed that allowance has been made for the inevitable apparent distortion that must occur in the human eye when looking at high vertical columns from below. The human eye, like the lens of a camera, distorts high vertical buildings so that the sides seem to lean inwards towards each other.

The ancient Greeks were aware of this and so arranged the columns and the horizontal lines of the steps that they look perfectly square when viewed from the ground. The blocks composing the great pillars must weigh some six to ten tons, but so accurately are they fitted that the joints cannot be seen. This

was achieved by placing a wooden pin into a central hollow in the lower stone which also fitted into the centre of the upper stone and then grinding the upper stone round and round until the two stones fitted absolutely perfectly. The surface decoration was of course cut afterwards.

The discovery of cement, and that hard bricks could be manufactured by baking the clay in a fire instead of sun-drying them, made possible the building of the cities which have sprung up all over the world in the last two thousand years.

The necessity of attempting to house vast populations as cheaply as possible has resulted in the construction of houses resembling rectangular brick boxes, one against the other in long rows, each side of the street, and as space in large cities has become more and more valuable the houses are now being built up in the air in the form of towers. This particular form of obtaining the maximum possible accommodation on the minimum possible space has found its greatest application in New York and other American cities, where buildings have been put up with as many as 120 stories.

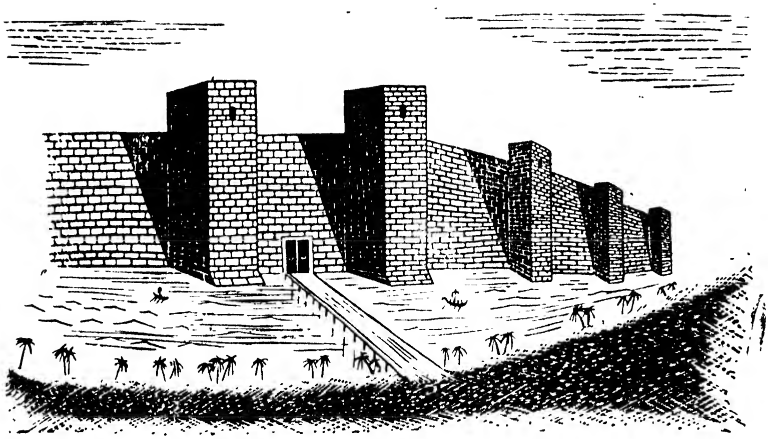
The use of steel girders and ferro-concrete has made possible the construction of enormous buildings of almost any desired shape and, if it has not added to the picturesque appearance of the modern city, has at least begun to do away with the rows of brick boxes which were so popular in Victorian times, and which still disfigure the roads leading into and out of our modern towns.

The next phase, it seems, will be to build the houses deep down under the ground to make them safe from air raids, and to revert to the conditions of a rabbit warren.

When our forefathers built a house or public building they intended that it should far outlast their own lifetime; they laid firm foundations, they made massive walls and they took particular care to see that so far as possible it was protected against the effects of wind and weather. They hoped that their descendants would continue to inhabit it for many centuries, or if it were a public building that it would long remain as a monument to their memories.

They were often successful as may be seen in many an old Elizabethan Manor House or Town Hall, but in course of time fire destroyed many of these buildings or time and weather so ruined them that they had to be pulled down.

The idea, however, behind the builders was permanence and stability. Even when they built a bridge or a culvert it was no temporary structure, but meant to last for centuries.



In recent times, owing largely to the changing conditions produced by rapid transit and altered conditions of living, we no longer desire that our houses should last for ever. We have come to realise that most houses and buildings are out of date in a little over thirty years and require to be reconstructed. It is better and usually cheaper to pull a building down and reconstruct it than to attempt to adapt it to modern requirements. In large cities like London, where ground is very valuable, properties are continually being pulled down and replaced by others higher and more commodious.

One would imagine that in consequence of this very evident tendency for frequent reconstruction that modern buildings would be made in such a way that they can be easily pulled down, but curiously enough this is not so. Most large modern buildings, and not a few small ones, are built in ferro-concrete, which is probably the most indestructible form of building that has ever been invented.

The Pyramid of Cheops at Cairo has lasted over four thousand years, but it is quite possible that such a building as the Dorchester Hotel, which is built entirely of ferro-concrete, will last much longer, provided it is not pulled down to make place for something better.

The old buildings that our forefathers constructed are easily pulled down and their destruction is not very expensive, but a modern ferro-concrete building can only be pulled down with the greatest difficulty and at considerable expense. Demolition

has to be carried out piecemeal with mechanical drills worked by compressed air and oxy-acetylene blow pipes to cut through the steel rods which are everywhere embedded in the concrete.

A modern ferro-concrete building is more difficult and costly to destroy than one of the ancient pyramids of Egypt.

It is a curious and anomalous fact that, in an age when it is generally recognised that most buildings will require to be entirely demolished and reconstructed within a comparatively short period in order to make room for improvements, we should construct new buildings of almost indestructible material that we know can only be demolished at enormous cost; yet such appears to be the case.

The time will come when our descendants will curse us for the indestructibility of our buildings and wonder why we could not have foreseen the necessity of so constructing our buildings that they would, when the time came for them to be replaced, be pulled down with the minimum amount of labour and the least possible expense.

CHAPTER XXVI

ARTIFICIAL LIGHT

OUR ancestors' first attempt at artificial light was by means of burning sticks or torches with the help of which they were able to move about in the dark and to light up their caves. Later, lamps made with rush wicks floating in animal fat took the place of torches for indoor illumination, and later still candles to a large extent took the place of lamps. The discovery of illuminating gas in the last century made general lighting possible, and to-day we have exploited electric light to such an extent that our streets and houses are so brilliantly illuminated that we have almost become independent of sunlight.

This is a great achievement, but man cannot claim precedence in the use of artificial light, and it is even doubtful if he has yet discovered the best and most efficient means of producing light. The very best electric lamps at the present time do not show an efficiency of more than twenty per cent. That is to say some eighty per cent of the energy expended is useless and does not result in light, being wasted as heat either in the lamps themselves or in the wires and apparatus used for producing the current.

Natural gas provided artificial light in many parts of the world long before the discovery of the production of gas from the distillation of coal. Many people must have read Rider Haggard's famous novel "She" in which a cavern is described lighted by burning natural gas. This is by no means a fantastic piece of imagination on the part of the author, as such forms of artificial illumination must have existed in the neighbourhood of volcanoes and oil deposits in many parts of the world from the accidental ignition of natural gas between fissures in the ground.

The Chinese are accredited with being the first people to make use of such gas for artificial illumination of houses. They piped the gas from salt mines by means of hollow bamboos into their houses and then ignited it at some form of porcelain burner.

One of the most extraordinary forms of artificial light is that provided by some of the insects and fishes. Some of the deep sea fishes, that is the fish that live in the vast depths of the great

oceans where no sunlight penetrates at all and where it is pitch darl., carry what may be called headlights which give off a bright light, the object being, it is believed, to attract other fishes so that they will fall an easy prey to the fish carrying the light. How this light is produced we do not know but that it is a very efficient form of light production there can be little doubt.

Still more remarkable is the light produced by the fireflies of America and the West Indies, and the glowworms of these isles. The fireflies are quite small insects of the beetle variety. They belong to the family of insects known as the Elateridae and the light comes from oval spots on the abdomen; even the eggs of these insects are luminous while still in the ovary. The light they emit, though momentary, is exceedingly brilliant and is unaccompanied by any heat. Were heat generated in the production of the light, as is the case with our methods of producing artificial light, such as gas and electricity, the small insect would be completely burnt up, judging by the intensity of the light produced.

The light does not appear to be the result of any process of oxidation and is quite unaccompanied by heat. The manner in which it is produced is at present an enigma, but it seems to have some relation to the form of light known as phosphorescence, which is seen in decaying matter and occasionally in the ocean.

Sometimes at night in a calm sea the whole ocean seems to be lit up from underneath by the phosphorescence due to minute organisms floating in the water.

Could we discover how to make a similar form of light as efficiently as the fireflies we could obtain nearly eight times the amount of light for the same amount of energy we now expend on light production, and all our streets and parks could be brilliantly illuminated all night. No doubt in time we shall succeed in finding how to produce artificial light with an efficiency of eighty per cent as compared with the output of energy, but at present we cannot do better than twenty per cent, and the fireflies are far ahead of us in light production. Not only do fireflies produce white light, but some produce green and red light. The light, though it lasts only a few seconds, is quite bright and one could read a book by the light given off by half a dozen fireflies shut up in a bottle.

CHAPTER XXVII

CENTRAL HEATING

IT is generally supposed that what we are accustomed to call central heating of houses and buildings is quite a modern invention which has only been developed within the last fifty years or thereabouts. Even now houses and hotels with central heating in England are the exception and not the rule, though in France and the United States almost all the larger buildings and most of the better class houses have central heating of some kind or another, the most usual system being to convey hot water or steam from a central boiler in the basement through pipes to radiators in all the rooms and passages. In the more modern systems a thermostat is fitted which automatically regulates the temperature by increasing or diminishing the furnace heat according to the temperature outside.

Another system which is extensively used in France is to have a furnace in the basement and air conduits to each room which allow the heated air to pass up through the various rooms.

The principle of central heating for houses is, however, very old. It was highly developed by the Romans, many of whom went to live in the northern parts of Gaul and in Great Britain, even as far north as Newcastle, and they found it necessary to heat their houses during a large part of the year. Instead of using open fires, as has been the custom here for the last ten or more centuries, they had their houses built with central heating and very efficient it must have been. This system can be seen to-day in the remains of ancient Roman villas in various parts of England, especially in the ruins that have been unearthed at Verulamium, now St. Albans.

The walls of the houses were built with columns of hollow baked bricks so that flues formed by the hollow bricks were present in all the walls and these flues were so arranged that they all communicated with an underground chamber under the ground floor of the house. In this underground chamber a big fire was kept burning and the heated air passed through the channels in the brick walls and escaped through flues or chimneys on the roof level.

This system would keep all the rooms warm on even the

coldest day and was more effectual and certainly more economical and convenient than having open fires in each room. The fuel did not have to be carried about the house to the various rooms and there was only one furnace to look after instead of a number of different fires, and this was in the basement where it was out of the way and easily reached from outside the house itself. It was no doubt both effectual and convenient, and probably worked almost as well as the steam or water radiators now in use. It was certainly cleaner and more economical of fuel than the open fires of our parents.

Central heating for houses, therefore, was certainly in fairly common use from 1500 to 2000 years ago, though a knowledge of this method of heating houses seems to have entirely disappeared with the fall of the Roman empire and not to have been revived again until quite recently. Yet what a godsend it would have been in the Norman castles of the eleventh and twelfth centuries with their cold stone walls and damp passages.

But central heating is much older than the Roman Empire for it has existed in beehives for certainly two million years. A beehive not only has central heating, but air conditioning as well. During winter, if the temperature of the hive falls to about fifty-five degrees Fahrenheit, the bees all collect together into a dense mass hanging from the roof and move about quickly; keeping in continuous motion. They keep crawling about in all directions. The result of this constant movement is to generate heat so that the temperature soon rises to about seventy-five degrees. Then they remain quiescent until the temperature has again fallen when the whole process is repeated. By this means the temperature of the hive, even in the coldest weather, is kept at a temperature somewhere between fifty-five and seventy-five degrees Fahrenheit.

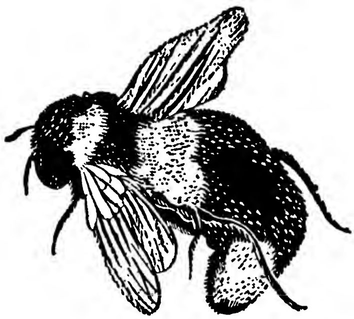
In the Spring, when the hatching of the new brood of grubs is proceeding, the temperature of the inside of the hive is raised by the same means to about ninety-four degrees, which is the most desirable temperature for the hatching grubs.

The worker bees crawl rapidly about over the comb and thus not only raise the temperature of the air, but reduce the heat losses from the comb by their bodies.

Should the weather be hot and the internal temperature of the hive too high, the worker bees all start fanning with their wings, and thus produce a draught of cool air which improves the ventilation and reduces the temperature.

By this method of air conditioning the interior of the hive is kept constantly at the optimum temperature, whatever that may be, according to the outside atmosphere and the internal requirements of the hive and its population. During the time the grubs are hatching the heat is kept up to the maximum, while in the winter when there is little going on it is kept at an economic level that is not too uncomfortable and does not require too great a consumption of the valuable honey stored away in the combs.

It will be seen that central heating and air conditioning are by no means modern inventions which have only recently been adopted, but are quite old and have only, so to speak, been rediscovered in modern times. The insects had made use of the principle and adapted it to their requirements long before man had even discovered how to make a fire.



CHAPTER XXVIII

ARMAMENTS

AT the present time when all the great nations have been doing their utmost to destroy their enemies with the most deadly lethal weapons, it is interesting to study the history of armaments in the past.

Until the discovery of gunpowder the only weapons of importance were cutting and piercing instruments (such as swords and spears) and bows and arrows.

In these days one can kill one's enemy without ever seeing him by blowing him to pieces with explosives or making holes in him with the bullets from a machine gun. Alternatively one can destroy or damage him with poisonous gas, or set him or his property on fire with incendiary bombs, or blow an entire city to fragments with a small atom bomb.

There is, however, nothing very new about any of these methods, as in principle they have all been used before, many of them long before man ever appeared on the earth at all.

Fighting between living organisms, either for survival, for defence against attack, to obtain food or shelter, or for other reasons, is in some form or another as old as the world, and has been going on ever since living things first began to swim in the oceans or crawl about on the land or fly the skies; and in the course of ages many organisms have developed strange and fantastic weapons of attack and defence, some of them even more ingenious, and certainly more objectionable, than those exploited by human beings during the last twenty-five years.

Perhaps the best examples occur among the ants and termites. Some of these insects have developed a soldier caste whose sole purpose in life is to make war on other colonies of ants, or to defend the community to which they belong. The soldier ants are much larger than their fellows and their mandibles have been over-developed into formidable pincers with which they can crush the head of an enemy ant, or bite him into two pieces.

So over-developed are the heads and mandibles of these soldier ants that they are not able to obtain food for themselves, and have to be fed by the worker members of the colony from

the general food store. By themselves, powerful as they are, they are helpless and would soon starve to death.

They go out against an enemy colony in battle formation and the fight is to the death, the losing side as a rule being completely exterminated. Nor is the battle left entirely to the soldier ants. The workers assist to the best of their ability and some of them have anticipated man in the exploitation of chemical warfare.

An ordinary worker of the common field ant, *Formica protensis*, will fix herself by her middle pair of legs and project a stream of poisonous formic acid from her behind straight at the advancing enemy, causing death or paralysis.

I once had the opportunity of seeing the end of a battle between a colony of red and black ants in a country hedgerow. The red ants, who were slightly the larger, were winning. Vast numbers of black ants were strewn over the battlefield between the two ant-hills, with here and there bodies of red ants who had died in the battle, for judging by the number of corpses it had been a very severely contested battle. At the time of my arrival the battle was practically over and the red ants had obviously won the day; they were hunting out black ants wherever they could find them and slaughtering them without mercy.

They were invading the enemy's ant-heap and dragging out their victims to be killed. Meanwhile the red workers were busy carrying off their wounded comrades and killing all the black ants, or at least so it seemed. Others again were busy dragging into the light of day the pupa grubs from the enemy's ant-hill.

What they intended to do with the infants I was not able to see. Maybe they intended to eat them or perhaps only to kill them by leaving them exposed to the sun and rain, but I don't think it was with any intention of protecting or preserving them that they were pulling them out of their homes. Slaughter was the order of the day; many thousands had died already on both sides, and more were being killed. I think revenge and not mercy was the object of dragging the enemy's babies into the open.

What I much wanted to discover was what they proposed to do with their wounded comrades who were being helped towards the red ants' nest. Were they going to be nursed back to health, or just put out of their misery? I was not able to find out, but I like to think that they were being taken tenderly to the shelter of their own home, there to be fed with sweet juices and have their toilet attended to, so that with good food and care they might recover to fight again.

The termites, or white ants, have developed their methods of warfare along more specialised lines than have the true ants. In addition to soldiers with most formidable cutting jaws, who can bite great pieces out of their opponents, they have a corps, or special caste, called "nasuti," who have long snouts which are connected to special glands on each side of the neck. These glands secrete a very sticky chemical poison, which they can project from their mouths at the enemy in a liquid stream. The result of this is that any of the enemy termites that are unfortunate enough to be caught in the stream of liquid become completely gummed up and entangled in the sticky substance; not only are they themselves completely incapacitated, but they probably adhere to numbers of their companions, so that the enemy are soon converted into a sticky mass of bodies, and are unable any longer even to defend themselves.

When we consider that termites live entirely in the dark in tunnels and subterranean chambers, the value of this form of chemical warfare can be appreciated. In the narrow confines of the dark tunnels, where the battles take place, the chemical warfare corps must be able to take a terrible toll of the enemy, with little danger to themselves. The dark passages by which the enemy have entered must soon be blocked with a sticky mass of entangled enemy, who are unable to retreat and must form an immovable obstruction to any further advance of reinforcements from behind.

Let us imagine a battle between two colonies of termites as described by a termite reporter in the Pink colony:

"For some time there had been trouble between the Pinks and the Whites, whose nest was situated about twenty yards away. The Pinks' nest was a very large one and the population was little short of a million. It was quite an old colony, while the Whites were comparatively new comers, who had migrated to their

present situation within the last few years from a grove of gum trees.

"There had always been trouble between the two colonies, but it was not until recently that the Whites had encroached upon the territory of the Pinks. Lately they had pushed their underground galleries into the Pinks' territory and had tried to possess themselves of a large tree stump which the Pinks considered to be their own property.

"Numerous encounters had occurred in the subterranean passages and on one occasion something like a pitched battle had taken place which ended with the Whites being driven away from the tree stump and their galleries leading in that direction being destroyed.

"There had been peace for a time, but the Whites were short of food and could find no suitable supplies of raw material within easy access, and had been obliged to go farther and farther afield to obtain what they wanted.

"The situation became more tense when a wooden cart with a broken axle was left near the Pinks' nest. The Whites claimed that they should be allowed to use the old tree stump and that the Pinks should be content with the wooden cart. But this claim the Pinks refused to consider; they would not countenance any trespassing on their territory and refused to consider themselves in any way responsible for the Whites' lack of raw material.

"It was evident that sooner or later the Whites would have to fight or would be obliged to migrate once more to some area where food was more abundant. The Whites were not so numerous as the Pinks, but there was no very great difference in numbers.

"The underground passages between the two colonies were frequently breaking into each other and minor skirmishes occurred before the breaks in the galleries were closed up again. It became clear that a major battle would have to be fought between the two colonies to decide who was to remain in possession of the area, and the Pinks' sentries in the outer galleries were doubled to give warning of an impending attack.

"The first alarm came when a sentry reported that the main gallery leading towards the tree stump had been broken into by the Whites in several places and that enemy soldiers were swarming into it. Almost at the same time came a report that another of the main galleries on the side towards the Whites' nest had been invaded.

"All available forces were at once called up and a large detachment of nasuti were sent at once to hold back the enemy in the two main galleries, while several detachments of soldiers were

sent to break through, if possible, in the rear of the enemy and attack them from behind.

"A large force was kept in reserve and the remainder were sent to find a way round and if possible attack the White citadel itself. Scouts were sent out to call back all those who had already left the nest on their daily business.

"The nasuti (chemical corps) attacked the advancing columns of Whites in the main gallery with streams of chemical poison, but the latter retaliated in kind and very soon a whole section of the main gallery was completely blocked with a struggling and entangled mass of termites, who could neither advance nor retreat, and whom it was dangerous even to approach. The mass swayed like a jelly, but none of the combatants could free themselves and were doomed to die slowly and painfully in the dark tunnel without any possibility of escape or succour.

"The same thing occurred in the other main gallery, except that the main body of the Whites got much closer to the Pinks' nest before they were brought to a standstill.

"Meanwhile fierce fighting had been going on in some of the side galleries where Pink soldiers had succeeded in breaking into the Whites' galleries behind the main columns. Many of these regiments were completely exterminated, but not before they had killed numbers of the enemy, and as one regiment went down it was followed by others, so that gradually the battle spread to all the galleries between the two nests.

"As one battalion was killed it was succeeded by another, wave after wave, until the enemy were driven back or the gallery became blocked with the slain. The battle went on without ceasing for several days, sometimes one side obtaining a slight advantage and sometimes the other.

"On the second day a large detachment of White soldiers almost succeeded in forcing their way into the Pink citadel. They drove back the workers, whom they met, with terrible slaughter, but a detachment of Pink soldiers arrived in time to hold them up, while a chemical corps was sent for. The nasuti, when they arrived, squirted streams of poison down the gallery entangling their own soldiers and the enemy indiscriminately, but completely blocking the passage with corpses. At the same time another party of Pink soldiers quickly cut a new gallery to break into the first one some way in the rear, and then the nasuti squirted poison into the rear column of the Whites so that they were completely cut off both in front and behind.

"Thousands and thousands of termites had died, and most of the galleries were blocked with corpses so that they were quite unusable, but in the meantime new galleries were driven forward by both sides.

"After three days numbers began to tell and the Pinks were everywhere attacking the White citadel.

"At last they broke in and a fearful battle ensued in the dark galleries of the Whites. No quarter was given and the order of the day was kill or be killed. After five days of continuous fighting there were no Whites left. The Queens and Kings had been dragged out and slaughtered, and those workers who had survived the battle had been driven out into the blinding sunshine.

"More than half the Pinks had died and a large percentage of the survivors were more or less damaged, but the White colony no longer existed. Its food stores had been carried away, its babies eaten or killed, and only a few miserable workers escaped into the neighbouring forest."

* * * * *

The bees depend entirely upon chemical warfare, using the stings of their tails. They have not, however, developed any soldier caste or specialised fighting strain. Every worker bee carries a poisoned dagger in his pants which he can use should the occasion arise. The poison is formic acid, which, as anyone who has been stung by a bee or wasp will appreciate, is a very unpleasant form of poison and causes extreme pain and irritation when pricked into the skin.

Bees do not apparently often fight each other, though they use their stings to drive away any strange bee or other insect who may attempt to enter the hive. Their weapon is chiefly used for what we may call police work, rather than for warfare.

Nevertheless they can, if the occasion calls for it, put up a marvellous fight against an enemy, even though the enemy may be several thousand times as powerful and large as themselves.

Bees are left alone by other animals because their powers of defending themselves are known and respected. Even the lordly elephant has a wholesome respect for a bee hive and will never intentionally interfere with it; while should he be so unfortunate as to step on one, he will remove himself as quickly as possible from the vicinity regardless of the fact that there may be men on his back.

Many an unfortunate man has found himself in serious difficulties because the elephant he was riding stepped on a bee-hive and then stampeded wildly through the jungle to try to shake off the clouds of angry bees who were pursuing him and sinking their poisoned daggers into all the vulnerable crevices of his thick hide.

Bees will drive away from the neighbourhood of their hive any inquisitive cow, dog, or other animal who approaches too closely, or who threatens to damage it, and they never fail to be successful, except in the case of man and of the honey bear. The latter, owing to the protection afforded by his thick, hairy coat, is not afraid of being stung and as he has a particular fondness for honey he breaks open the hive and, in spite of all that the bees can do to defend themselves, helps himself liberally to their accumulated stores of honey.

CHAPTER XXIX

RADAR

THE word Radar was invented during the war and refers to a system of ultra short radiations called micro waves. These very short wireless waves do not spread out in all directions, as is the case with the longer radio waves, but can be focused in a very narrow beam like a searchlight.

Both Radar and the other method of direction finding which uses long radio waves and is called Loran, short for Long Range Navigation, were high secrets during the war and the ordinary man knew nothing about them except what they could do, and not much about that. The censorship has now been lifted but it will be some time before full descriptions are available of these wonderful methods of direction finding over great distances.

Loran gives the greater range, 800 miles in daylight and about double that distance at night, while the Radar range is about 250 miles.

Both methods were extensively used by the Allies during the later stages of the war. Enemy ships and submarines could be detected and pin pointed many miles away and depth charged or bombed accurately without ever being seen by the naked eye.

British bombers were able to fly blind over Germany and find an exact target on the darkest night without fear of mistake, and by the same means could be steered home again to their own airfields. Enemy planes could be detected hundreds of miles away and their courses plotted, and even enemy rocket planes could be seen and shot down by Radar-directed guns.

Radar or Loran methods can be used to direct a plane or a ship to a definite but entirely unseen goal hundreds of miles away and will tell the pilot when he has reached his objective.

Radar has made it possible for man to find his way through space with certainty and accuracy in spite of fog or darkness.

This surely is something quite new and for that reason should find no place in this book. But I propose to relate a few facts which make it seem at least possible that something of the kind has been in use for thousands of years, though not by man.

Jean Henri Fabre, the famous French entomologist, who all his life made a close and careful study of the habits and behaviour of insects, has described how he reared some Emperor Privet

Moths from caterpillars which he brought from Northern France, where they are indigenous, to his home in the South where this variety of moth has never been seen.

He left the larvae in a cage in his study and one day two female Emperor moths emerged. These were the only Emperor Privet moths for miles around and there were certainly no other moths of this species for fifty miles in any direction. Yet next morning there were four male Emperor Privet moths in the study trying to get into the cage where the females were. Fabre was so struck by this experiment that he repeated it on another occasion with exactly the same result. How had the male moths found their way to Fabre's study? He came to the conclusion that a sense of smell could not possibly explain the phenomenon and that the moths have some means of communication quite unknown to us. That in fact the moths were able to send out and receive messages of some kind over very long distances by some method of which we are entirely ignorant.

The Golden plover of the Pacific migrates annually from Alaska in Northern America to Hawaii, an island in the South Pacific. It is generally believed that when they migrate these birds make a continuous flight of some two thousand miles over the open sea there being no possible place where the birds can rest near the direct course between Alaska and Hawaii.

Since the general rule in migrations is that the young birds go first and are followed later by their parents and the older birds, it seems clear that knowledge of the route from previous experience cannot explain how the birds find their way over the great distance involved.

It has been supposed that some inherited instinct enables them to find their way. But this is no answer to the problem since we have not the vaguest idea how instinct works or even exactly what we mean by the word. The truth is that we can offer no satisfactory explanation. The paths by which the birds migrate are constant and are followed year after year. How do they find their way and how do they know where to go?

It does not seem possible that sight can have anything to do with it as the birds fly day and night, and in any case over the ocean sight would be of no assistance as there are no landmarks. Moreover, migrating birds usually fly quite low when over water.

One can quite well understand that the urge to migrate and even the time of migration may be due to inherited instincts; but this does not help us to comprehend how the birds know where to go or how they can find their way over such great distances without any apparent guide.

It seems only reasonable to suppose that the birds have some special means of orientating themselves in space and of following a set path by some sense apparatus which we know nothing about. Unless indeed it is something similar to the radio direction findings developed by us and the Americans during the war.

That something of the kind must exist seems certain, and in our present state of scientific knowledge there is no other way in which we can explain the undoubted fact that vast numbers of young birds, whose experience has hitherto been confined to quite a small area, are able to set off on a flight over two thousand miles of open sea where there are no landmarks at all and, flying day and night without a stop, reach a given spot in the South Pacific which they have never seen before and of which they have no experience. Yet this is actually what they do!

Migration is most spectacular in the case of birds but almost

equally remarkable things occur with animals. The migration of the lemmings of Sweden and Norway is a case in point. The normal lemming is a small rodent rather like a big rat, but having only a rudimentary tail, and is coloured like a guinea pig, orange and black. It is normally a very timid beast living among the rocks on high mountain plateaus above the tree line.

Periodically a certain lichen growing between the stones becomes abundant and is consumed by the lemmings. This lichen contains a certain vitamin which has the effect of profoundly stimulating the lemmings who eat it. The sexual organs become greatly developed, breeding occurs more frequently than usual and the litters are more numerous. The animals themselves change and become bold and even fierce. This process goes on very fast and soon results in the comparatively small colonies of lemmings becoming vast swarms so numerous that they cannot find food or even standing room and are forced to migrate. Like a great carpet they move down the mountain sides into the woodlands and make blindly towards the Atlantic ocean.

The migration of these hordes of lemmings may take several years to complete but they all go in the same direction, followed by innumerable enemies such as owls, hawks, ferrets, etc., who prey upon them. They keep steadily on through Sweden and Norway until they reach the North Sea where they are all drowned swimming blindly out into the Atlantic regardless of the fact that there is no chance of surviving.

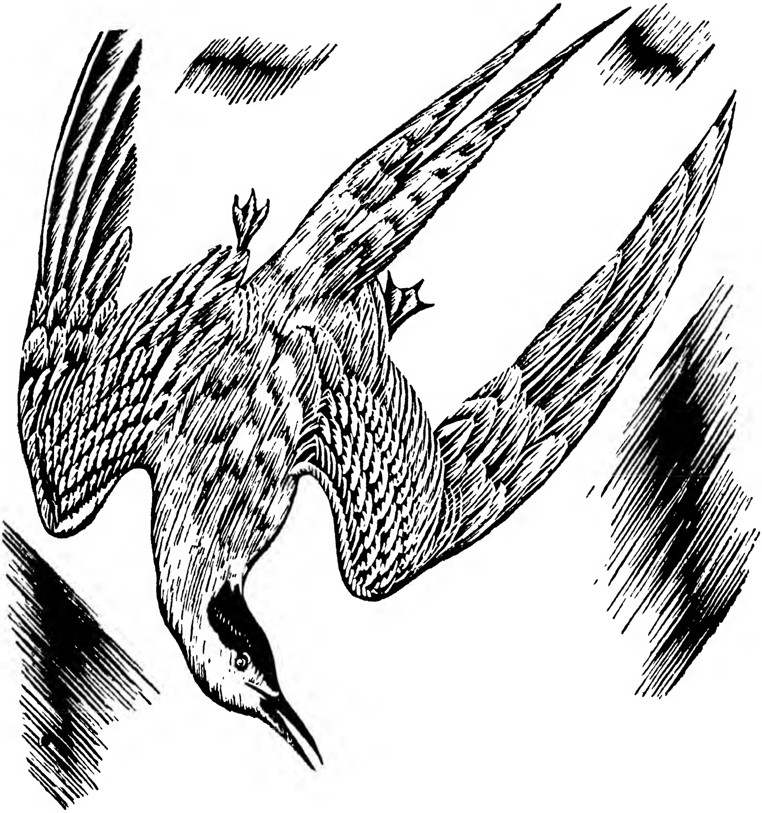
I was once in Norway during such a lemming migration. The whole place simply swarmed with these little rodents. One came across them everywhere, dead and alive, for everyone killed them—dogs, cats, men and even fish. I have seen them try to swim across a raging river with very little hope of reaching the opposite bank.

The trout gorged themselves on lemmings till they could hardly swim. Hundreds of dead lemmings drifted down the river and swirled around in the eddies, and on shore their dead bodies were all over the place and live ones sat up on their hind legs and barked at you as you passed.

The following year when I again visited the same part of Norway there was not a solitary lemming to be found anywhere.

Here again one can explain why the lemmings start to migrate but we have no explanation of how they find their way in a certain direction, always the same at each migration.

These migrations only occur at intervals of several years but



when they take place are always along the same paths and always with the same fatal results.

A small form of antelope in South Africa called a springbok sometimes behaves in just the same way as the lemmings, moving in vast herds so large that they are said to cover the landscape in every direction like a solid mass until they reach the sea where they drown by millions.

Salmon spawned in a Norwegian river find their way eventually, as small smelts, across three thousand miles of the North Atlantic to the Canadian Banks where in the course of several years they develop into adult fish.

When the urge to breed comes to them they start off to retrace the route they followed as small fry, back to the same river where

to become most serious. The population, filthy and half starved, afforded an ideal breeding ground for such an epidemic, and it would probably have killed many thousands as such epidemics have always done in the past. But as the result of the use of D.D.T. the destruction of the lice, which act as the carriers of the disease, was so complete that the epidemic quickly died out owing to the fact that there were very few new cases to carry on the infection once the necessary measures had been taken.

Now that D.D.T. has become available for use in every household it means that our clothing need no longer be damaged by moth. The old clothing which most of us are now obliged to wear would not be full of holes had this chemical been available during the last seven years. Nat Gubbin's famous suit 'Moth's Relish' would still be entire, or nearly so.

Nearly all the really unhealthy parts of the world, especially those in the East, owe their evil reputation to the presence of poisonous insects and if, as seems at least probable, these insects can be readily and quickly destroyed, such places will soon become as healthy as London or Paris.

White ants, or termites as they should be called, do a tremendous amount of damage in many parts of the world. They destroy books, furniture and any wooden structure that has not been specially treated to stop them. Shoes and other leather equipment are very soon rendered quite useless in places where termites exist. The legs of tables and chairs have to be stood in tins or other receptacles filled with water or they soon collapse owing to the termites having hollowed them out from inside. Termites exist in many parts of the world in vast numbers and render life for humans in the same areas very difficult. An occasional spraying with D.D.T. should go far to prevent their inroads.

But it is probably a mistake to suppose that termites are entirely injurious. In tropical countries where vegetation grows at a great speed the termites do a great deal to break up and destroy fallen trees and hasten decomposition of decaying vegetation.

Insects are not all injurious and many are extremely useful. Hornets, for instance, destroy hundreds of common flies daily as also do wasps. Dragon flies destroy vast quantities of small flies and midges. The decomposition of dead animals and dead matter generally is mainly due to insects who act as the scavengers and grave diggers of the animal world. Without them the dead matter

would accumulate and smell to high heaven. They are as necessary in maintaining what we sometimes call the balance of nature as bacteria who finally break down the dead matter into its primary components and allow the chemical substances to be used again in constructing new life. The insects do the first part of the job and make it possible for the bacteria to complete the process.

There are extraordinary possibilities in the use of this new insecticide. An enormous area of South Africa is almost uninhabitable by human beings because of the tsetse fly, which kills men and cattle and makes it impossible to make use of horses or cows. The tsetse fly will certainly fall a victim to D.D.T. when man once more has time to tackle it properly, and vast areas of South Africa can be opened for agriculture or other purposes.

What exactly the result will ultimately be we can hardly even guess at present, but we do know that everywhere nature is in a state of what we call equilibrium and that if man introduces new conditions which upset this equilibrium, entirely new factors come into operation which can lead to quite unforeseen results. (See 'Natural Enemies,' Chap. 4.)

It is as if man put 'a spanner in the works'. Something has got to break and we can't always, indeed very seldom, foresee what it will be or what the ultimate consequences may result in producing. Nature is a very complicated affair: one thing depends on another; there is nothing straightforward or simple about it, and when the 'balance of nature', as it is often called, is upset the most surprising consequences can ensue.

All the plant world throughout this planet depend for reproduction upon the fertilisation of their flowers from one to another, and this has been carried out by bees and other insects who go from flower to flower and plant to plant and incidentally convey the pollen upon which fertilisation depends. It is quite evident that the indiscriminate use of D.D.T. will stop the fertilisation of plant life everywhere and it is certain that if this is allowed to happen we may succeed in converting vast tracks of country into arid wastes uninhabitable by insects, beasts, or men. All animals are dependent primarily upon plant life and if the latter are unable to reproduce themselves because there are no insects, life on this planet will come to an end. The invention of the atom bomb may well prove, as many of us think, to be one of the worst disasters that ever took place. It has not helped the Allies, as we should have won the war without it, and it threatens overwhelming disaster to future generations. But D.D.T. has

almost as great potentialities. Suppose we imagine that at some future time the Soviet Union or the U.S.A. were powdered, say every three months, with D.D.T. powder from the air for a couple of years. The results would be appalling. All annual plants and vegetables would cease to exist and vast multitudes would die from starvation simply because there would be no insects to fertilise the plants. The atom bomb might destroy people quicker but the D.D.T. powder would cause a much greater disaster in the long run.

These inventions need very careful handling and it is very doubtful if our politicians and those who to a large extent control our destinies have sufficient brains or common sense to protect us from the fools and braggarts who for their own ends may make use of such inventions to the detriment of the people of this globe.

CHAPTER XXXI

WHAT WAS THE BIGGEST EXPLOSION?

MOST people, if asked to say what was the biggest explosion that has ever occurred on this planet, would answer the explosion of the atomic bomb on Hiroshima, Nagasaki or in the Bikini Atoll. But they would be entirely wrong.

On 27th August, 1883 a far bigger explosion took place, the noise of which travelled three thousand miles and the effects of which were evident over nearly the whole earth. The air wave, or blast as we have been accustomed to call it, went right round the world and the waves produced in the sea by the explosion were recorded eight thousand miles away.

Two kinds of waves were caused: long waves with periods of over an hour and shorter but higher waves with a shorter period. The combination of these two waves caused a disturbance in the sea which in places reached a height of over fifty feet. The destruction caused by these great waves of water was enormous and caused the death of more than 36,000 human beings in an area which could not be described as at all thickly populated. All the towns and villages in the neighbourhood were completely destroyed. Red hot cinders and rocks covered an area larger than the whole of France, and in many places as much as a hundred miles from the explosion the forests and land were covered with debris and rocks to a depth of nearly 100 feet. This was all due to the blowing up of the island of Krakatoa in the Sunda Strait in the East Indies.

The island of Krakatoa consisted mainly of a volcano which at its highest point rose to 2,623 feet above sea level. The whole island was only about eighteen square miles in size and inhabited only by a few natives. The explosions continued from August 26th to the 28th and the most violent occurred on the 27th. Instead of the island there was a cavity under the sea with its bottom nearly 1,000 feet below sea level. The sea rushed back to fill the cavity thus formed only to be converted into superheated steam when it came into contact with white hot lava. This blew the water away again and this process kept on being repeated.

It is not known how many times the sea rushed in and again retreated but it went on for a long period with the most violent explosions which threw thousands of tons of rock into the air. In the final colossal explosion it has been estimated that fourteen cubic miles of rock shot into the sky in one vast cataclysm.

The noise of the largest explosion was heard 3,000 miles away. It took ten days before the blast had spent itself. The ashes changed the colour of the atmosphere as far away as London and New York. The dust had not entirely settled in the early Spring of the following year. All life of every kind was destroyed over many square miles in the air, the land and the sea. Nothing comparable with this enormous eruption has been recorded in history and it is certainly unique in this respect. The biggest atom bomb explosion is a mere fleabite compared with Krakatoa's performance.

Actually the Krakatoa explosion is itself a very small affair compared with the explosion which must have taken place in the Sun when the Earth, Mars, Venus and other planets were split off; but although we can observe the results of this solar explosion we have no record of what actually happened. It is an interesting fact that the greatest explosion of which we have any exact knowledge was not due to T.N.T., atomic energy or any chemical eruption, but was due to our old friend steam confined in an enclosed space. The pressure produced must have been enormous and the steam must have been superheated to fantastic limits and present in enormous volume.

CHAPTER XXXII

SCIENCE ON TRIAL

WHAT has science done for the world?

A great many people to-day, if asked this question, would answer it by saying: "Nothing." Of course, what is really meant by the question is, what has science done for the benefit of man? The world, if by that we mean this globe on which we live, is profoundly uninterested in science, and all that has been done to it is to knock the crust about here and there and alter the distribution of some of the fauna.

Well, let us consider this question and see if we can arrive at an answer. To start with, let us see what damage, what trouble, what distresses, can be attributed directly to the scientific discoveries of the last hundred years.

Let us suppose that we are putting science on trial and are making out the various counts to be submitted to a jury of twelve just men and true.

We should first of all submit that medical science has, during the last hundred years, done a very great disservice to the human race by discovering how to reduce infant mortality.

Over a hundred years ago more than half the children born into this world died before they reached adult life. As a result only the strongest and healthiest succeeded in reaching manhood or womanhood, and consequently in propagating their kind. All the weakly, mentally defective, deformed or diseased children died and never had the chance of passing on their various defects and weaknesses to the succeeding generations.

The human stock tended to be strong and virile since it was only bred from the tough men and women who succeeded in getting through infancy and childhood to adult life.

There was no serious overcrowding of populations because, although the number of births was greater than it is now, only a few, a very few, ever grew up; whereas now the vast majority grow up and breed children of their own, even if they are defective, mentally weak, or riddled with inherited disease.

But medical science has done worse than that. It has practically

abolished plague, small pox, malaria, typhus, dysentery, yellow fever, cholera, and a number of other diseases which previously used to kill whole communities. The plagues of the Middle Ages killed periodically more than a third of the entire population of England and other countries. Those who were fortunate enough to survive were at least not overcrowded and inherited the goods of their dead neighbours, so that they tended to be better off.

In 1577 what were known as "the Black Assizes" were held at Oxford. A catholic bookseller called Jenks, was tried at these Assizes on a charge of "profaning God's word and staying away from Church." The court was unusually crowded owing to the fact that the case had attracted a great deal of attention. Poor Jenks was condemned to have his ears cut off, but he had his revenge. Typhus fever had broken out in the prison and a large number of those present at his trial died. Three of the judges, the sheriff and under-sheriff, all but one of the Grand Jury and five hundred other persons in the town.

In the American Civil War some ninety thousand of the Federal Armies were killed or died of wounds and one hundred and eighty-six thousand died of disease.

The world never had a chance of becoming over-crowded, since epidemics of disease of one kind or another destroyed the populations almost as quickly as they bred, but to-day, thanks to medical science, all this has been stopped on any really large scale and as a consequence the population of the world has doubled in fifty years and seems destined to continue increasing in geometrical progression.

On what other counts can we accuse science?

Let us take food. As the result of scientific improvements in agricultural methods, the production of food stuffs have been so incredibly increased that there is far more than enough food for all the men and women in the world, in spite of the great increase in the populations. But has this really benefited humanity as a whole? It certainly has not. Many of the products of agriculture, such as wheat, coffee, barley and rubber, became so cheap, before the late war, that it was not worth while to grow them and vast quantities of wheat and coffee were burnt or allowed to rot while production was limited by quota, although the world was clamouring for these necessities of life.

The benefits that science has conferred upon humanity have not been used to help humanity except in so far as they could be exploited at a profit for the middle man.

Everyone could have clothes made of really beautiful plastic materials, which would be warm and comfortable, and quite cheap because they would not need to be woven. But if this happened it would cause disaster in the Lancashire cotton industry.

Science has made paper and printing so cheap that before the late war one could buy a good book for sixpence and a very large newspaper for a penny. As a result the output of literature to-day is colossal, but the quality has deteriorated.

Science has enabled human beings to move about with extraordinary speed by means of trains, motor cars and flying machines, and they can talk from almost any part of the globe to one another in a few minutes, but this has been accompanied by a terrible increase in noise and bustle.

The most serious indictment against the scientist is that by his discoveries he has made war between nations and peoples a horror, whereby whole peoples are destroyed and maimed, and where no final result can be attained except by starvation or extermination of one side or the other.

Now let us consider the defence that science can put up to this indictment.

The scientist has not worked for any material ends, but has just sought after knowledge for its own sake, unconcerned with the outcome. The results have to a large extent been accidental, and certainly not foreseen by the scientist.

Thus to start off with science must plead that even if some of the results of modern discoveries in physics, medicines, chemistry and electricity have not resulted in benefiting humanity, at least science has not been responsible for the way in which these discoveries have been exploited; nor has the discoverer as a rule benefited personally. While earldoms, peerages, baronetcies and knighthoods have been showered upon the industrial magnates and financiers who have exploited the discoveries of the scientists, the latter have had but few rewards of a material kind, and still remain amongst the most poorly paid members of the intelligentsia in every nation.

The average scientist has to be contented with an income of some £400 to £500 a year, with little chance of saving up for his old age, and if he should make a discovery of world-wide importance he may be fairly certain that somebody else will reap any material harvest that may accrue and be rewarded with the peerage or knighthood which by rights should be his. We may

possibly have a monument put up to him long after he is dead, and his name may become immortal, but he is extremely unlikely to reap any reward during his lifetime.

At any rate the scientist cannot be accused of being a materialist. If he succeeds in making two ears of wheat grow where only one grew before, it is in the hope that this will be of material benefit to the human race, but too often what happens is that it

enables the financial magnates to fill their pockets and burn the additional food, which by rights should be allowed to reach the consumer.

But is it true that science has not brought benefit to mankind?

In the near future the average citizen of the civilised world will be richer than he has ever been; that is, if one counts riches in the right way, namely in goods and comforts. He will be better housed, better lighted, better clothed, better warmed; he will have better food, his children will be better educated; he will be able to travel more easily and cheaply; he will have more to interest him and much better facilities for entertainment. He will no longer be in everlasting fear of dying from some disease, and his expectation of life will have been increased by twenty to twenty-five years. His prospect of reaching the age of sixty or more is now so good that he can insure his life quite cheaply, whereas his counterparts of the fourteenth century had little chance of reaching the age of forty, and had no kind of insurance.

He is allowed to-day to have some share in the government of his country, at any rate in England and the democracies. It is true that it does not count for much, but still it is something, and until he has very considerably increased his general intelligence it would be unwise for him to have more.

But are we satisfied that science has made out a good case, and if we join the jury, are we prepared to bring in a verdict of "not guilty" for science?

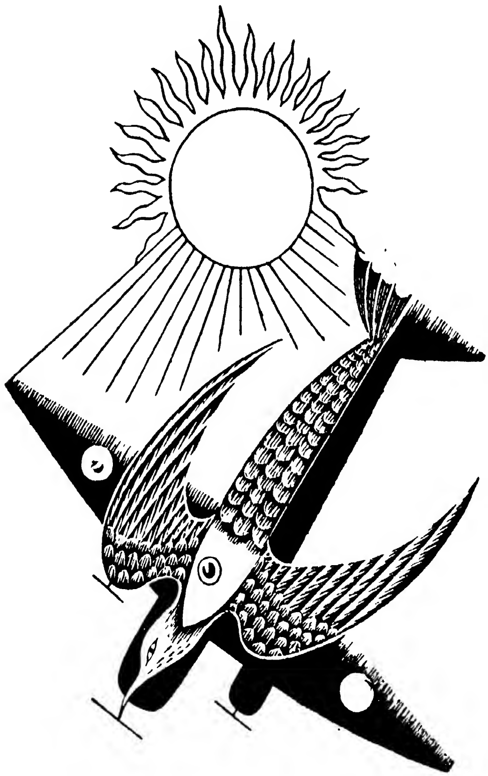
On the whole, I think we would, for if we stop to think for ourselves and not merely to follow the shouts of the orators and the drums and flags of their followers, we shall realise that the trouble is not the fault of science, but of the manner in which scientific discoveries are used.

They should be used for the benefit of all and not exploited for the advantage of the few or the extermination of nations. It is the financial system of credits and debits that is wrong, and if this were put right, everyone would benefit from the riches that science has poured out upon the earth.

But why are we being exploited and how can this be prevented?

This is a difficult question and one that is not easy to answer. One or two facts, however, stand out. The tremendous increase in population that has taken place as the result of scientific discovery in the last one hundred years has counterbalanced the advantages that science has brought to humanity, and has made it possible to exploit scientific discoveries for the benefit of the few

rather than the many. Man must take control of his population. Increased food supplies must mean more food, not more babies. A lowered death rate must mean better children, not more "cannon fodder." It is no good doubling the food supplies if at the same time you double the population. It is foolish to breed more children simply to increase the sale of motor cars; yet that is just exactly what is happening.



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